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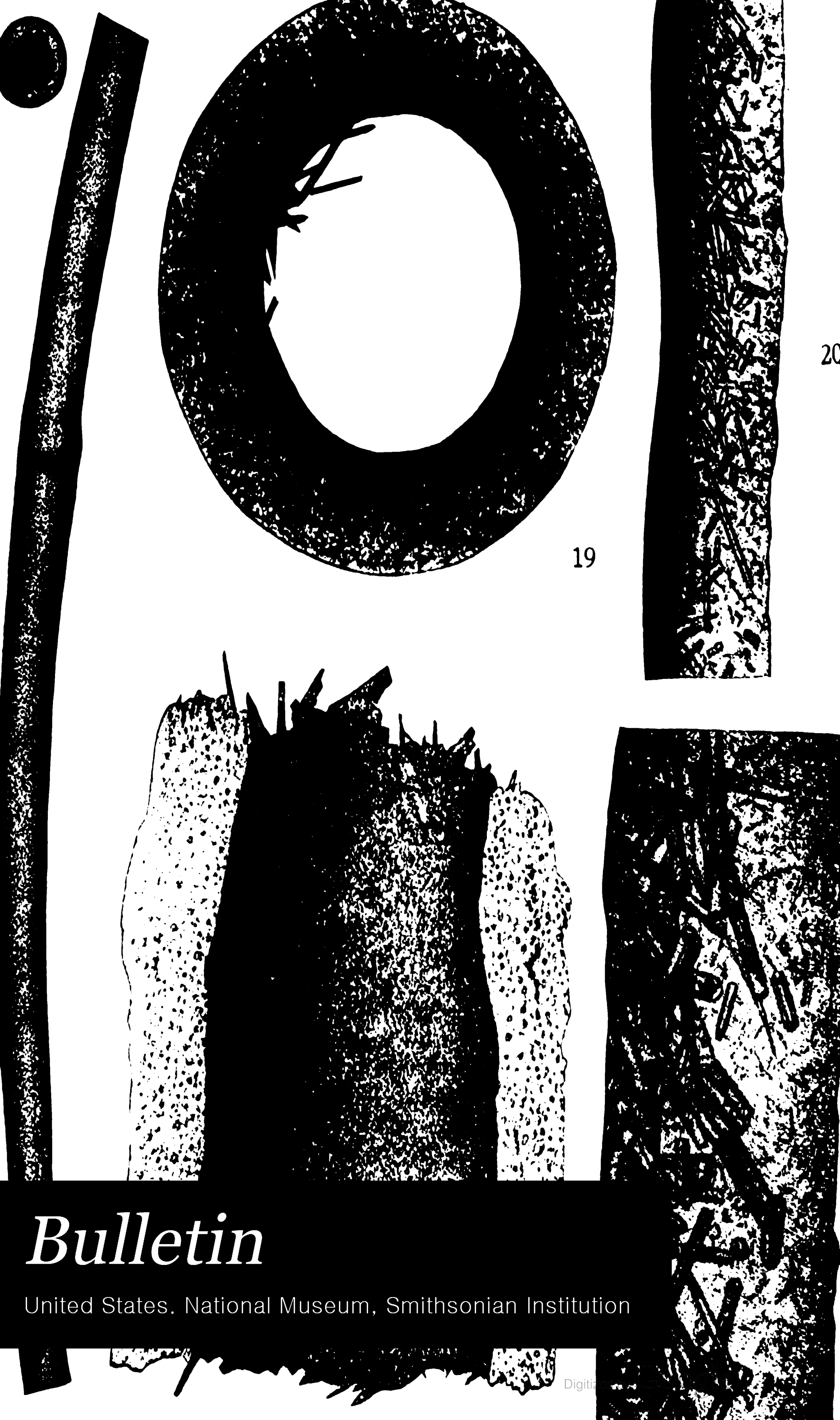

# Bulletin

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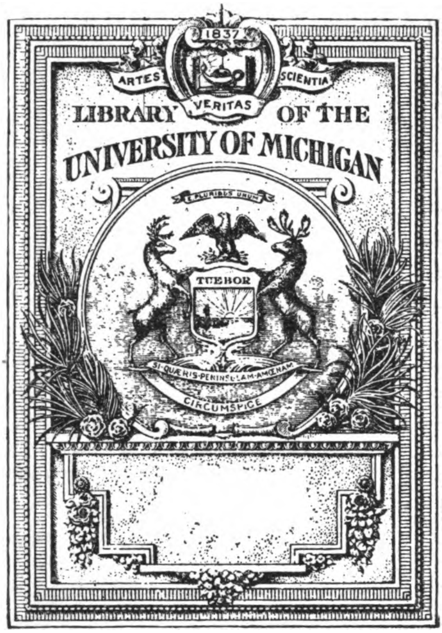

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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
**Bulletin 71**

# A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN

## PART I. ASTRORHIZIDÆ AND LITUOLIDÆ

BY

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WASHINGTON
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# ADVERTISEMENT.

The scientific publications of the United States National Museum consist of two series—the *Proceedings* and the *Bulletins*.

The *Proceedings*, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original, and usually brief, papers based on the collections of the National Museum, presenting newly acquired facts in zoology, geology, and anthropology, including descriptions of new forms of animals, and revisions of limited groups. One or two volumes are issued annually and distributed to libraries and scientific organizations. A limited number of copies of each paper, in pamphlet form, is distributed to specialists and others interested in the different subjects, as soon as printed. The date of publication is printed on each paper, and these dates are also recorded in the tables of contents of the volumes.

The *Bulletins*, the first of which was issued in 1875, consist of a series of separate publications comprising chiefly monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, and catalogues of type-specimens, special collections, etc. The majority of the volumes are octavos, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable.

Since 1902 a series of octavo volumes containing papers relating to the botanical collections of the Museum, and known as the *Contributions from the National Herbarium*, has been published as bulletins.

The present work forms No. 71 of the *Bulletin* series.

RICHARD RATHBUN,
*Assistant Secretary, Smithsonian Institution,*
*In charge of the United States National Museum.*

WASHINGTON, D. C., *June 18, 1910.*

# INTRODUCTION.

This paper is the first part of a work the intent of which is to describe and illustrate the Foraminifera of the North Pacific Ocean. This part includes the families Astrorhizidæ and Lituolidæ, together often known as the Arenaceous Foraminifera. These are usually considered the more primitive group and are therefore treated first.

The collection of recent Foraminifera in the United States National Museum has been carefully studied in so far as it represents the area in question. From the work of the various vessels of the Navy Department, the Coast and Geodetic Survey, and the Bureau of Fisheries a mass of material has accumulated which has been of great value in this work. A more detailed account of these collections will be given later.

There have been few works dealing with the Foraminifera of this area, and such records as exist have been included here. Except where acknowledgment is given, the figures have been drawn by the writer from material in the collection of the U. S. National Museum or have been reproduced from photographs taken at the National Museum of specimens in the same collection. Where recorded species are not well represented in the collection, figures from other works have been used and due acknowledgment given.

A considerable number of changes in the nomenclature and systematic arrangement have been made in an attempt to separate more clearly species and groups which, after a study of this material, seem to be distinctive.

I wish to express my great appreciation of the kindness with which the U. S. National Museum and its staff have so freely met my various needs in the preparation of this work.

JOSEPH AUGUSTINE CUSHMAN.

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# A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

## ASTRORHIZIDÆ AND LITUOLIDÆ.

By Joseph Augustine Cushman,
*Of the Boston Society of Natural History.*

## GENERAL ACCOUNT.

The Foraminifera are for the most part minute animals varying in size from a fraction of a millimeter to several millimeters in length, but may develop a test several inches across; these, however, are rare exceptions. A few species live in fresh or brackish water, but the great majority live in the ocean. They occur at all depths, but are most frequent at moderate depths in the ocean basins, where they form characteristic deposits—the so-called ''globigerina ooze.'' In the vicinity of tropical coral islands many species occur in great abundance.

The animal itself is a single-celled form with one or many nuclei, as will be later explained. The test, in many cases at least, is really an internal structure, as the thin film of protoplasm which covers it in the perforate forms, and probably in others, is capable of secreting the material of the test, to repair breaks, etc.

Comparatively little is known concerning the animal of the Foraminifera except in certain littoral species. The great mass of the work on the group has been confined to a study of the empty tests. In the present work the material has been dried in almost all cases. As a result little has been noted in regard to the animal itself.

As single-celled animals the Foraminifera are especially interesting, and their structures do not need explanation on the basis of organs or tissues. There is much beauty in the curves of the test and in its ornamentation, the patterns of the latter often being very intricate.

For some time after their discovery the Foraminifera were thought to be a group of the cephalopods, and many of the coiled species have the appearance of minute nautiloid cephalopods. Many of the generic names were applied before the true relationships were known.

Many of the coiled forms were early described as species of *Nautilus*, and it was not until 1835 when Dujardin recognized the relationship of the group to the rhizopods that their systematic position was finally settled.

The classification of the group has been very differently treated by later writers. Led by W. B. Carpenter, there grew up what may be termed the English school of workers on this group. Four names stand out prominently, those of W. B. Carpenter, W. K. Parker, T. Rupert Jones, and H. B. Brady. The first three especially worked on the basis of no sharp lines of demarcation between species or genera or even between larger groups. The group was supposed to be very variable, in fact so much so that genera were recognized as tentative only and not really distinct. Brady, while holding many of the same views, nevertheless described many new genera and species, drew the lines more closely for the genera, and worked out a fairly good classification of the whole group. He was, however, led by the same plea of variation to unite recent forms with often dissimilar fossil species, on the basis of similar characters in one part or another, even while the whole test was often very different. With the large series obtained in the present work it is possible to show, not only that variation is not so great as was thought by the English school, but what was by them called variation is not variation at all but definite stages in the development of the test, which often at different stages has very different characters. In the light of the present knowledge of the life history and the microspheric and megalospheric forms these supposed variations take on a decidedly different aspect and become of use in the separation of genera rather than in uniting them. While these points are not so clearly brought out in the arenaceous forms described in the first part of the present work, they are well seen in certain of the other families.

Schlumberger, in distinction from the English school, had very different ideas as to the variation and the classification of various forms. He argued that with other groups the identity of fossil and living forms becomes small in the Eocene, and in the Cretaceous is hardly known, yet the workers of the English school had no difficulties in uniting recent species with even Jurassic or still older forms. Schlumberger argued that when such similarity existed it was simply a lack of characters, and that the two forms were potentially distinct.

Distribution has been thought to be of little account in the group, either by regions or by depth. Certain species, for instance, are recorded by Brady as from 18 to 3,950 fathoms, and with a worldwide distribution. With material from scattered stations and a worker attempting to explain all differences on the basis of variation such views may be held, but with larger series from many stations, such as have been available in the present work, the material has seemed to prove the contrary in regard to many species. With the lines of demarcation of species more closely drawn, it will be apparent that certain of them have well-defined areas of distribution and are found only between certain bathymetric altitudes. Not only is this true in regard to species, but various species form definite faunas, as will be later discussed. With plenty of specimens for comparison from different areas it is fairly easy to show the specific differences and the actual amount of the variation.

Throughout the group of the Foraminifera there is a nearly complete series, from a simple gelatinous covering of the cell in some of the fresh-water forms to the complex calcareous test of the higher groups. The fresh-water forms, while not considered in the systematic part of the present work, are nevertheless of especial interest on account of their primitive characters. In *Myxotheca* the simplest sort of covering is found, a gelatinous test which is flexible, so that it takes the shape of the changing form of the cell. There is here also no definite aperture, the pseudopodia being pushed through at any point. In others of the fresh-water forms the test may be of flexible chitinous material, but has a definite shape when the animal is at rest and usually one or more definite and permanent orifices.

In the marine species, which form the basis of the present work, there is usually a definite, specific form to the test and the aperture is permanent. The materials used in making the test may be grouped in two classes, (1) those derived from foreign sources, and (2) those secreted by the animal itself. The foreign materials are derived from the bottom on which the animal lives, and therefore even in the same species found under different conditions there is some variation in the character of the materials used. In general, however, there seems to be a certain amount of selective power on the part of certain forms, and such characters have been used as of generic rank in systematic work. The foreign material most frequently used is the mud or sand of the ocean bottom, but certain forms use sponge spicules, either making them into a soft felted mass (*Pilulina*) or arranging them in a definite manner and firmly cemented (*Technitella*). Other foraminiferal tests may be used, as may various small bodies which come within the range of the animals. The cement in the agglutinated tests may be chitinous, of iron oxide, or calcareous.

Of these calcareous tests two sorts have been recognized, one with a definite aperture or series of apertures and with minute pores (the perforate group), the other with a definite aperture or series of apertures but without minute pores (the porcellanous group). By many writers the latter group, represented by the Miliolidæ, has been held to be primitive and a group which had not developed perforations. On the other hand, certain evidence, such as the perforate condition of the early chamber of *Peneroplis* and other genera, would indicate that they are derived from the perforate group and that the lack of pores instead of being a primitive condition may in reality be a specialized one derived from a condition in which pores were developed throughout the life of the individual.

In general the test of the Foraminifera may be single chambered or many chambered. Contrary to the impression given by certain works on the group, the process of adding chambers in the Foraminifera, while superficially like budding or gemmation, is not necessarily or usually accompanied by nuclear divisions. That is, instead of the new chambers being potential individuals they are simply integral parts of one cell, and in the uninucleate form the single nucleus is found in about numerically the middle chamber. In the process of adding a new chamber a portion of the protoplasm is protruded from the aperture and a new chamber wall then formed about it. In some cases a complete wall is formed with each newly added chamber, but in others the adjacent parts of previous chambers form the inner walls of the new chamber and new walls are formed only on the free parts of the protoplasmic mass. In the open tubular test, such as *Astrorhiza* or *Hyperammina*, increase in the protoplasmic body is accompanied by addition of material at the open end of the tube and an increase in size results. In single-chambered types, such as *Lagena*, the manner of increase in size is problematical, if there be any at all. In such forms the entire test may be made in its completed form at once after division, as is the case with certain of the freshwater Rhizopods.

## STRUCTURE.

### COMPLEX TESTS.

In the tests having more than a single chamber the apertures of the first-formed chambers become internal, as a rule, and a complexity of relations to the outside medium is thus brought about. One of the simplest arrangements of the chambers is a linear series. Such an arrangement is seen in *Reophax* and *Hormosina*. Another very common plan of arrangement is a planospiral, as in *Ammodiscus*. This may be varied by having the revolving line in a spire and then the whole test becomes trochoid, as in *Trochammina*. Another common arrangement is a biserial one, the chambers being on opposite sides of the axis, as in *Textularia*. These four plans or some modification of them are the characteristic arrangements for the chambers in most of the secreted tests. Oftentimes more than one plan of arrangement enters into the formation of the test. Dimorphism was used for this, but that term has been used elsewhere with a very different meaning. As here viewed, this life history with several distinct methods of growth has a deeper significance than has usually been attached to it. It seems to have a definite phylogenetic bearing in each particular group, as will be shown in certain of the families to be taken up later, when the details will be discussed at length. The term "dimorphism" would hardly cover the case in some genera, where eight or more distinct stages may be made out, each with its characteristic form of chamber, yet all appearing successively in a single test.

The number of chambers in the complex tests varies from a few to a great many. Where the size of the test becomes considerable and the chambers correspondingly large, the chamber is often divided up in various ways into chamberlets, as in *Orbitolites*. In such cases the adjacent chamberlets are usually in free communication with one another. The walls of the chamberlets give additional strength in many forms in which they are developed. Another characteristic modification in some genera is the development of labyrinthic structures in the interior of the chambers. Such structures are seen in *Cyclammina*, *Haplostiche*, *Fabularia*, etc. In general, it seems to be a mark of the culmination of certain lines in development, and many of the genera which developed such labyrinthic structures are now extinct. From the appearance of a series of such tests of one species at different stages in development, it would seem as though this labyrinthic condition was developed as a secondary growth in the chamber. One of its uses may be to give added strength to the test, but this does not always seem to be the case, for it may occur in tests which are characterized by thick walls.

### APERTURES.

The aperture in a given species seems to be rather constant when the development is understood. Much has been written upon this subject; apertural characters have been used by some authors as a basis for systematic work and discarded by others as very variable. In a few specimens it may seem at first sight as though the apertural characters were very variable, but with a large series showing different stages in development another phase of the matter is presented. In certain cases there is a very decided change in the condition of the aperture, but these changes appear at definite stages in the life history, and all may be seen by cutting back a single full-grown individual. In general, it has seemed from the present study that apertural characters, when studied in large series, are a rather dependable set for systematic work, and this will be shown to be true in the Miliolidæ and Lagenidæ especially.

In many species teeth of various sorts are developed in the aperture, and these teeth are subject to various modifications. It can be demonstrated that these modifications occur in a definite sequence, and that this sequence is important from a phylogenetic point of view.

In a considerable number of genera a definite tubular neck is developed, with the aperture at its end. This neck is seen in many genera in a great many modifications, and in *Lagena* the tube may be inverted and be directed into the chamber of the test.

It is obvious that a very long slit-like aperture may be a source of weakness to the test, especially when it is at the edge of a thin chamber. Usually in such cases, as in *Orbitolites*, the animal changes its aperture from a single one in each chamber to a considerable number. This is often coincident with the development of chamberlets, but not invariably so, for multiple apertures occur in *Peneroplis* where there are no chamberlets.

### ORNAMENTATION.

Many of the tests of the Foraminifera are beautifully ornamented. Raised costæ, striations, knobs, spines, and punctate areas form the main types of ornamentation. Several of these or combinations of them may occur in a single species, the form of the ornamentation often changing as the chambers of the test are developed. Certain of the simpler forms of ornamentation may occur as parallelisms in widely separated groups. As a rule, the proloculum and early chambers are smooth and unornamented, but there are certain exceptions, as in *Nodosaria*, for example, where in some species ornamentation may occur on the first chamber. In specialized genera it is not uncommon to find certain of the species with the early portion of the test ornamented, but the last-formed chambers with a loss of ornamentation and a consequent development of smooth chambers. On the other hand, there may be a thickening of the test from without and the covering of the chambers already formed with a secondary growth, often spinose. Such a condition is seen in some species of *Bulimina*.

### SECONDARY CANAL SYSTEMS.

Ordinarily the different parts of the test are connected with one another by the previous apertures, but in some cases, notably in *Polystomella*, there is a secondary canal system which is very complex and runs to all the parts. This has been worked out by Carpenter and others in detail.

### COLOR.

The color of the empty tests in the Foraminifera is not a prominent feature. Among the arenaceous forms the cement is often ferruginous, and when the iron is in sufficiently large proportion it imparts a reddish or yellowish-brown tinge to the whole structure. With this exception the arenaceous forms are usually dependent for their coloring upon the material from which the test is made up. This material may be of various colors, from the white of coral or siliceous sands to black, with the various colors usually associated with ordinary sand particles. In living specimens of certain of the arenaceous types, *Ammodiscus* for example, the newly formed portion of the test is often of a much lighter color than the rest of the test; on the other hand, in other forms, as in *Hormosina ovicula,* the tips of the chambers are often much darker than the rest. In the chitinous tests the usual yellowish-brown color of chitinous structures is present, and is somewhat variable in its tone.

In the secreted calcareous tests the usual color is white when empty. There are various exceptions, a reddish or pinkish color being most common, such as appears in *Globigerina rubra* and *Truncatulina rosea,* or perhaps more pronounced in *Polytrema minaceum.* In other calcareous species, as in various species of *Discorbina,* there is a brown color rather prominently developed. This is often confined to the earliest chambers, and the later ones may be white. In many species when alive there is probably more or less color which disappears when the test is empty.

## LIFE HISTORY.

For many of the Foraminifera two distinct phases have been discovered. One of these—the microspheric form—has a proloculum or first chamber of much smaller size than the other—the megalospheric form. These two forms are to be looked for in all species.

The microspheric form has a number of nuclei, often a larger number than there are chambers, scattered irregularly through the protoplasm of the body. There seems to be a rather definite relation between the size of the nuclei and the size of the chamber in which they occur, the larger nuclei being in the larger chambers and the reverse. Apparently these nuclei simply divide in their reproduction during the growth of the test.

When the animal attains its adult stage there is a great increase in the number of pseudopodia, and the entire protoplasm either leaves the test and accumulates about the exterior or is drawn into the outer chambers. Finally, each nucleus gathers a mass of protoplasm about itself and secretes the proloculum of a new test. This newly formed proloculum is of the larger type and is the first chamber of the megalospheric form, instead of being of the same size as that of the microspheric parent from which it was derived. The megalospheric form differs from the microspheric form in having a single nucleus. This does not divide, but moves along as new chambers are added, keeping in about the middle chamber numerically. Nucleoli appear in increasing numbers as the growth continues, and finally the whole nucleus breaks down and a great number of minute nuclei appear. These draw about themselves portions of the protoplasmic mass and then divide by mitotic division. Finally, the mass leaves the test in the form of zoospores. These are then supposed to conjugate and to give rise to the small proloculum of the microspheric form, thus completing the life cycle, although the actual process of conjugation has not definitely been observed in this group. The empty tests left behind must form a large proportion of the dredged Foraminifera. The two forms may be distinguished by the size of the proloculum and, when sufficiently known, by other characters as well.

The microspheric form is thus the result of a conjugation or a sexual process, while the megalospheric form is the result of simple division or an asexual process. As a rule the megalospheric form is by far the more common, and in many species the microspheric form is very rare, or even as yet unknown. The microspheric form, while it starts as a smaller individual, in most cases attains a much larger size than the megalospheric, as might be suspected from the nature of the reproductive processes by which it is formed. In species where there are definite stages in development it is usually the microspheric form which repeats these most fully, these stages being reduced or entirely skipped in the megalospheric form of the species.

In some cases the megalospheric form may give rise to a group of megalospheric young instead of to zoospores. On the whole, the life cycle agrees well with the alternation of generations as seen in certain other groups of animals.

## PELAGIC FORAMINIFERA.

All of the Foraminifera may be divided into two classes, those which are known to live at the surface, relatively a small number, and those which have been found only on the bottom, which form the great majority.

The pelagic species number but little more than twenty, and of these few are really common at the surface. The two genera which have more than a single species are *Globigerina* and *Pulvinulina*. The following species have been taken at the surface: *Globigerina æquilateralis*, *G. bulloides*, *G. conglobata*, *G. digitata*, *G. dubia*, *G. inflata*, *G. marginata*, *G. sacculifera; Pulvinulina canariensis*, *P. crassa*, *P. menardii*, *P. patagonica*, *P. truncatulinoides*, *P. tumida; Hastigerina pelagica; Orbulina universa; Candeina nitida; Pullenia obliqueloculata; Sphæroidina dehiscens; Cymbalopora bulloides;* and *Chilostomella ovoidea*.

Of these species a few have been observed but once as single specimens, and at best are but doubtful members of this group. Others are almost never found on the bottom, and may be considered as truly pelagic species.

As a group the pelagic species are characterized by peculiar structures. In *Hastigerina pelagica*, for example, there has been noted a peculiar vacuoled condition of the protoplasm, in which it extends out from the body to several times the diameter of the test and is filled with large vacuoles. Many of the species have large apertures, and in some cases a number of secondary ones are present, especially in the last-formed chamber of the adult. There is also a tendency for the last-formed chamber to surround the preceding, ones either entirely, as in *Orbulina,* or in part, as in some of the species of *Globigerina.* Some of the species develop very long spines on the surface of the test. Most of the species also develop a spherical or nearly spherical test which, as has been shown by Rhumbler, is the form which requires the least amount of secretion to cover the animal. In the matter of the size of the perforations also there is a difference, even in species of the same genus, between those living at the surface and those on the bottom, those of the surface forms being several times as large as those of the bottom ones. In general, while the various structures mentioned are also found in the bottom species to some extent, they are strikingly characteristic of the pelagic Foraminifera.

Evidently the pelagic character has been developed independently, as there are members of three or more families represented. The structures which they have developed in common, therefore, are to be regarded as parallelisms due to similar environmental conditions.

## FOOD.

In general, the food of the Foraminifera consists of vegetable matter, the diatoms and algæ of various sorts furnishing the greater part. In some of the pelagic forms, however, it has been observed that copepods are caught and eaten, and some other Protozoa are also caught.

## COLLECTION AND PRESERVATION.

For one living near the ocean it is very easy to obtain material for making a preliminary study of the Foraminifera. On stones, on the piles of wharves and bridges, in fact upon almost anything that is stationary for any length of time in the salt water, the Foraminifera will be found in greater or less quantity. In the sand of tide pools many species may be found, and in the sand dredged from a few fathoms there are sure to be some tests present. If locality is not important, and one merely wishes to become acquainted with the various forms, they may be found in the sand from sponges, from the "chain lockers" of ships, etc.

For the study of a definite region involving any considerable depth of water a special dredging apparatus must be used, together with the various appliances used in deep-sea work. As such methods are too elaborate for individual work as a rule, it must be left largely to government vessels and to especially equipped scientific expeditions. For getting together material for the study of a definite fauna, such as that of the North Pacific, it is necessary to depend almost wholly upon the work of such specially equipped vessels. The samples that are brought up from the ocean bottom must be washed in some way to separate the mud from the other material. One of the easiest and most expeditious ways is to shake the material in a cloth immersed in water. This quickly washes out the mud and leaves the Foraminifera with more or less sand, fine shells, and like objects. Such material when dried is easily examined, and the Foraminifera desired may be picked out with the tip of a needle moistened slightly or with a fine brush.

For the mounting of the Foraminifera for permanent preservation nothing better seems to be available than the wooden slides mentioned by Dr. James M. Flint. These are of wood with a concave boring in the middle of one side. The slides themselves are 3 inches long and one inch wide. Some of them as used in the present study have been made thin enough to fit into an ordinary slide box, and have a small concave portion, while another lot has been used nearly twice as thick, but cut at the ends so as to slide into the grooves of a slide box. These latter are drilled with a larger and deeper concavity and are used for the arenaceous and other large species. The bottom of the concavity is blackened with drop black, and the cover is made of a slip of mica held in place by a spring made of a thin strip of brass bent to conform to the two sides of the slide with enough spring in the strip to make it act as a clamp to hold the piece of mica securely. This clamp may be easily slipped off when the specimen is to be critically examined, or with a hand lens the specimen may be studied directly through the mica. The specimens are dropped into the cavity and not fastened in any way, and are therefore available at any time for studying from any side simply by removing the cover and turning the specimen to the desired position. (See figure.)

For photographing, the specimens have been fastened to the bottom by a little glue, and if desired can be easily removed for study.

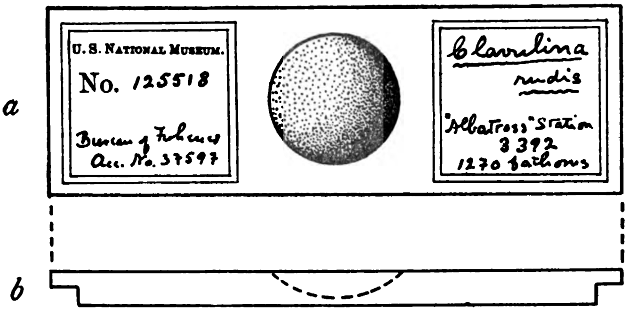
Great care should be taken in the making up of the slides to keep distinct the material from various stations, even though it may appear as all one species from widely separated localities. If previous collectors and workers had been more exact in some of these details it would now be easier to separate the various species and varieties.

In many of the families the necessity of studying sections of specimens is very great. This method, given by many writers, is the best to follow: The specimen is placed in position and fastened by a small drop of glue. When this has hardened the specimen is covered with balsam and heated until the balsam has penetrated into the chambers. After allowing the specimen to become hardened, it may be ground down on an ordinary hone, frequent observations being made to determine the plane of cutting. When the desired plane has been reached the specimen may be removed by dissolving the balsam with a little xylol and then the glue dissolved by water. By turning the specimen over and repeating the process a thin section may be obtained, which may then be mounted permanently. By this means the arrangement of chambers in the interior of a test may be studied, even when they may be entirely hidden in an ordinary external view.

## HISTORICAL.

The North Pacific Ocean as a whole has received less attention, except from the United States vessels, than any of the great ocean basins. The idea has been prevalent that it was largely a vast red-clay area of great depth. This was mainly a result of the voyage of the *Challenger*, which certainly did follow a course leading over such a portion of the bottom. On the whole, the generalization is true that the ocean bed of the North Pacific is a great red-clay area. In spite of this fact, there are, as was shown by the work of the *Nero*, considerable areas of globigerina ooze containing abundant Foraminifera. As the aim in the present work is to include all records for

*A*



*B*

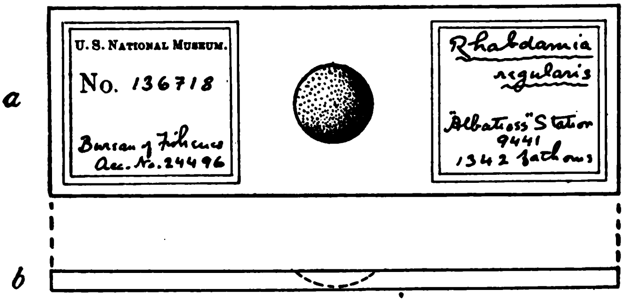


Fig. A.—Thick slide. *a*, surface view; *b*, side view, showing grooved end for fitting into slide box.

Fig. B.—Thin slide. *a*, surface view; *b*, side view.

this region, a short review of the work done on the Foraminifera will not be out of place.

Ehrenberg had material from many parts of the world, and some of his samples included specimens from this area. Carpenter's work really gives an idea of certain of the Philippine forms. He mentions several species as occurring here, and notes that they vary more or less from what he terms the same species from the Mediterranean. Definite data are not given, and the few species noted as occurring in the region are not given further attention in this work, as they are for the most part the larger and more common shallow-water species of the tropical coral-reef fauna.

It is in Brady's Report on the *Challenger* Foraminifera that the first real sketch of the foraminiferal fauna of the North Pacific is given, especially that of the deeper portions of the adjacent seas. A considerable number of species and varieties are recorded from this area, but the great majority of these are from three regions, really from three stations. In point of view of richness, these are, first, the coral reefs of the Hawaiian Islands, at a depth of 40 fathoms; next a station off Japan on the *Hyalonema* ground, in 345 fathoms; the third station is just west of the Philippines, in 95 fathoms. These three stations together furnished a large part of the North Pacific records of the *Challenger* Report. Many of the other stations gave but a few species; some none at all. From these facts it might be imagined that the rich fauna of this area is in the shallow water, and this has proved to be the case. As a rule, the globigerina ooze away from the oceanic islands is uninteresting, consisting almost exclusively of the pelagic types of *Globigerina*, *Pulvinulina*, *Sphæroidina*, etc. Near the islands it contains more species, but on the whole is far less interesting than the somewhat similar ooze of the North Atlantic.

In 1893 Picaglia[a] recorded twelve species from three stations in the mid-Pacific from the dredgings of the *Vettor Pisani*. Of these two were additions to the *Challenger* list.

In 1894 Schlumberger[b] recorded a number of species from a single station in the Sea of Okhotsk. Some of these were described for the first time. He noted the meagerness of the fauna of this particular portion of that ocean area, and his remarks have been confirmed by my examination of the *Albatross* material of 1906 from the same region.

In 1896 Goës reported upon the Foraminifera from the region between the Galapagos Islands and the coasts of Mexico and Central America.[c] The area covered was fairly represented in the material both as to depth and bottom conditions. A considerable number of new species was discovered, and from the list of species given much can be made out as to the characters of the fauna. Goës returned to the National Museum a set of nearly all the species he recorded, and his selected material has been carefully studied in connection with the present work.

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[a] Atti Soc. Modena, ser. 3, vol. 12, pp. 152–155.

[b] Mém. Soc. Zool. France, 1894, pp. 237–243.

[c] Bull. Mus. Comp. Zoöl., vol. 29, 1896.

In 1899 Flint's report on the *Albatross* Foraminifera [a] added to the previous knowledge by records from scattered stations on the west coast of North America and a few species from the western Pacific. Most of the stations from which the material was taken for his report were in the North Atlantic. His report on the *Nero* material [b] added a few records to the previous ones, although in that report as a rule only the genera were mentioned, the work dealing with oceanography rather than determination of the species in the deposits. Something of the general character of the fauna of various areas may be ascertained from the genera mentioned.

In 1906 Rhumbler reported [c] upon material from Laysan and the Chatham Islands. The material came from shallow water. Of the species recorded a considerable number were described as new. These records are especially interesting as they represent the littoral fauna not previously recorded, except from the Hawaiian Islands in the *Challenger* Report. Rhumbler's records show the existence of a shallow-water fauna of tropical character about these islands, and the new species indicate the individuality of these more or less isolated areas.

In 1908 Bagg [d] recorded a considerable number of species from the immediate vicinity of the Hawaiian Islands. These records add considerably to the recorded fauna of the shallower water as given in the *Challenger* Report. In this *Albatross* material the stations reported upon were mainly in globigerina ooze and for the most part lack the shallower water species so common on the coral reefs of this region. The series selected by Doctor Bagg has been examined and the results of this examination appear as the species are discussed.

Altogether the eight titles mentioned have built up a rather numerous fauna for the North Pacific, but the material that was available for all of them was rather meager when compared with the material available for the present work. As a result, not only has a very large proportion of the previously recorded species been rediscovered, but a great many species have been added, some new, and some previously described from other areas. The large series of specimens has added greatly to the ranges of distribution for species which were formerly known only from isolated stations and has shown the incorrectness of the determination of many species of this region as identical with species characteristic of the fossil beds of Europe.

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[a] Rep. U. S. Nat. Mus., 1897, (1899) pp. 249–349.

[b] Bull. 55, U. S. Nat. Mus., 1905.

[c] Zool. Jahrb. Abt. Syst., vol. 24, pp. 21–80.

[d] Proc. U. S. Nat. Mus., vol. 34, pp. 113–172.

## SOURCES OF MATERIAL.

*U. S. Fisheries steamer Albatross.*—The greatest part of the work of making known the ocean bottom of the North Pacific has been done by the U. S. Bureau of Fisheries steamer *Albatross*. For the last twenty years the *Albatross* has been in the Pacific Ocean and has occupied several thousand dredging and hydrographic stations. In the present work these will be referred to in the usual manner, as "station D5056" or "H3228," etc. Of the *Albatross* material, that from a considerable number of stations was available from the work of the earlier years. These stations were chiefly along the Pacific coast of the United States, British Columbia, and Alaska. During the early part of 1891 dredging operations were carried on off the coast of California, Mexico, and Central America, and out to the Galapagos Islands. The material collected was worked up by Goës and is recorded in his paper already referred to. Later, in 1891 and continuing into 1892, the *Albatross* was engaged in a cable survey between California and the Hawaiian Islands. About 550 stations were occupied and a mass of material from a definite line across that part of the Pacific was gathered. As is the case in so many parts of this ocean basin, the depth for much of the distance surveyed was too great for the existence of many Foraminifera, the majority of the soundings consisting of typical red clay. In certain parts of the area, however, Foraminifera were fairly common.

In 1902 the *Albatross* made an exhaustive dredging trip in the vicinity of the Hawaiian Islands. Much of the bottom material was unfortunately destroyed, but the remainder formed the basis of the paper by Doctor Bagg on the Foraminifera of this region. Fortunately, the cable survey of 1891 and the work of the *Nero* furnished new material from a number of stations in this area, and this has been available for the present work.

In 1906 the *Albatross* made an extended voyage of exploration in the northwestern Pacific, a region practically unknown up to this time. Material from this voyage, especially from about the islands of Japan, the Sea of Japan, the Sea of Okhotsk, etc., has been available in this work and has added very greatly to the knowledge of what may be termed the "cold-water fauna" of the North Pacific. Many other species were also added from the very interesting region off the southern coast of Japan where the *Challenger* made a few hauls with such satisfactory results. Some of the *Albatross* dredgings cover the identical areas where the *Challenger* dredged, and it is interesting to find again in the *Albatross* material certain of the rare species described by Brady in the *Challenger* Report as from this region only. The more extended work of the *Albatross* adds much to our knowledge of the real distribution of these species formerly known from only a single station.

*U. S. S. Nero.*—Next in importance to the work of the *Albatross* has been that of the U. S. S. *Nero*, which in 1899 and 1900 made a detailed cable survey across the North Pacific from the Hawaiian Islands to Midway Island, thence to Guam, to Luzon, to Guam, to Yokohama, to Guam, to Midway Island, and then back to the Hawaiian Islands. Thus a very complete line of soundings was made, giving, in connection with the 1891–92 survey from California made by the *Albatross*, a complete line of soundings and of bottom samples across the whole North Pacific. The work of the *Nero* by actual distance of the course of the survey gives on an average a record for every few miles of the distance. Such detailed work has not been available for any such distance before. Much of the work was in very deep water in red clay areas, and the results as to the Foraminifera practically *nil*, but many areas of shallower water were covered with typical globigerina ooze conditions. The areas about the various centers of work at Honolulu, Midway, Guam, etc., gave an excellent series of Foraminifera. About 750 bottom samples from work of the *Nero*, mostly from the shallower areas, were examined and much was thereby learned in regard to actual distribution of the various species, many of the results of decided importance in delimiting faunal areas for the North Pacific.

*U. S. S. Alert.*—A considerable number of bottom samples was available from the work of the U. S. S. *Alert* in the western Pacific. As a rule, these were in the vicinity of the Bonin Islands and near other volcanic islands, containing in general little of interest, yet certain of the samples had many interesting species and add stations which otherwise would not have been accessible.

*Miscellaneous.*—Scattered material from various sources has also been available, from the China Sea, Hongkong, and various shore stations in the Philippines. All have added interesting data, although the material from such sources was not usually rich in Foraminifera.

Strangely enough, the region from which the least material was available is that of the west coast of the United States. This is partly due to the fact that the *Albatross* when in these waters is often engaged in work other than that of dredging. Enough material is available, however, to show that the region is a peculiar one in many respects.

## DISTRIBUTION AND ITS FACTORS.

In relation to the Foraminifera there are three conditions which are of importance in addition to the character of the bottom—depth, temperature, and ocean currents.

In regard to the first of these conditions it may in general be said that there are almost no calcareous Foraminifera to be found in depths greater than 2,500 fathoms. There are certain exceptions to this, but the number of such exceptions is very small. In greater depths than this there are to be found certain species of the arenaceous Foraminifera, which have been found at the greatest depths that dredgings have been made. The reason for the practical disappearance of the calcareous forms below the 2,500-fathom line has not yet been definitely settled. It has been thought that the great pressure at that depth has made their dissolution much easier than at shallower depths, but this has not been conclusively demonstrated.

Besides the disappearance of certain groups of forms through dissolution, there are found to be rather definite limits to the range in depth of any particular species when a considerable series may be had for study. Many species are found only in very shallow water, such as *Alveolina*, *Amphistegina*, etc. They may be found occasionally at considerable depths in the vicinity of oceanic islands, such as Guam, where the currents carry them into deeper water, but even in such cases the tests show the effects of wave action and are as a rule tests which were apparently empty before they were carried out to this depth. In the neighborhood of such islands very strange mixtures of deep-water with shallow-water species may be found, and mingled with the other two are often many of the typical species of the globigerina ooze.

Bottom temperature has in some cases an apparent influence upon the distribution of certain species. For example, certain species of the arenaceous group which are ordinarily found in deep and cold water are found in comparatively shallow water in such regions as that of the Okhotsk Sea, where the bottom temperatures are very low. Apparently in such cases their presence at such depths is to be explained upon the basis of temperature. In a similar manner there are a certain number of species which seem to thrive only in the warm water of the tropics and are for the most part found associated with the other species of animals characteristic of coral reefs.

Ocean currents play an important part in the distribution of species in two ways—(1) by determining in part the distribution of ocean temperatures, and therefore in this way limiting or extending the range of certain species; and also (2) through their position and direction determining the distribution of the pelagic tests on the ocean floor. This will be shown in dealing with distribution of the various species of *Globigerina*.

With these various factors it is not surprising that definite faunas should exist in different parts of so large and varied a region as that of the North Pacific. In this study a number of rather definite faunas have been met with which may be clearly separated. In general the great ocean depths are very uniform, and it is in this portion of the ocean basins that universal distribution is to be looked for. Many species found at depths of 1,000 fathoms, for example, are probably to be found in similar depths in any of the great ocean basins. This is even more true of those species which are encountered at the 2,000-fathom line. At depths of less than 500 fathoms species occur which in many cases seem to have a rather limited range. Many such species have been found—species, for example, which were recorded by Brady from material from a single *Challenger* station, and have been found again in the present study on the *Albatross* material from exactly the same regions and at approximately the same depths. Such species may be considered as marking definite faunal limits where enough such species occur in any one region. On this basis the North Pacific Ocean may be divided up into several faunal regions, which, while they may have a considerable number of species in common, nevertheless have a distinctive character as a whole.

Among the most characteristic of these faunas may be mentioned the coral-reef fauna, as it may be conveniently called. This fauna, characterized by such genera as *Orbitolites*, *Alveolina*, *Peneroplis*, *Amphistegina*, *Polytrema*, etc., is found about the coral reefs of the Philippines, the Hawaiian Islands, Guam, and other of the tropical oceanic islands of this area. It is best developed about the first two groups of islands at comparatively shallow depths. In the north this fauna extends, with certain modifications, up to the southern portion of Japan, but so far as made out it is not developed at all on the eastern coast of the North Pacific. The same fauna is found in the Malay Archipelago, in various parts of the East Indies, off the northern coast of Australia, to some extent in various parts of the Mediterranean, and also a modification of it in the West Indies.

Off the coast of Central America and Mexico there is developed a peculiar fauna which is seen in a modified form in the deeper waters off the eastern coast of the Philippines. Certain of the species, or at least the genera, are also characteristic of certain parts of the extreme North Atlantic, where they have been described by Brady from the *Porcupine* and other dredgings. Some of the genera which are characteristic of this region are *Crithionina*, *Bathysiphon*, large species of *Reophax*, *Verrucina*, etc.

Off the coasts of Japan and of the Philippine Islands in green mud at depths of a few hundred fathoms there is another rather definite fauna, which is mainly characterized by many species of the Lagenidæ, such as *Sagrina bifrons* H. B. Brady, and many of the species recorded by Brady from the *Hyalonema* ground south of Japan in about 300 fathoms. This fauna appears to run northward a considerable distance along or off the Japanese coast and to extend eastward to the

Ladrone Islands and southward through the Philippines to the region north of Australia.

Besides these three, which are rather definite in their limits, there are many more minor faunas which may be made out, but which are not of sufficient importance to be mentioned here. One example, for illustration, is the cold area extending around the northern portion of the North Pacific and Bering Sea. This is marked by such species as *Polystomella sibirica* Goës, etc.

On the whole, while the North Pacific is not as interesting perhaps as is the North Atlantic, there are portions of it which are very rich in species which are represented by an abundance of specimens.

The systematic portion of the work has been written on the basis of the distribution in the North Pacific entirely, and the stations are given with this in mind. Occasionally mention of other regions is made, but only when this has some special bearing on this region.

## SYSTEMATIC PART.

## Order FORAMINIFERA.

Pseudopodia of fine threads, freely anastomosing to form a network; test typically with many minute foramina, in one family with a single aperture; wall of the test composed of chitinous or calcareous material when secreted, or of agglutinated sand, sponge spicules, shells, etc., usually secreting either no silica or a very little under certain conditions.

### [Family 1. GROMIDÆ.

Test usually chitinous, sometimes with a covering of foreign material; apertures one or more; as a rule inhabiting fresh and brackish waters.

As all the material available for the present work consists of strictly marine material, usually dredged from altitudes of several fathoms to the greatest depths, members of this family are not to be expected. They undoubtedly occur in the fresh or brackish waters of the coasts and larger islands. They will not be further considered here.]

### Family 2. ASTRORHIZIDÆ.

Test composed of agglutinated material for the most part, occasionally with a chitinous inner layer, consisting of a chamber with several openings or a tubular test open at both ends, or in certain forms, of a closed chamber with a single aperture, but throughout the family the test is not divided into a series of chambers.

The tests here included in this family are all of agglutinated material, but in some genera, such as *Rhizammina*, there is a chitinous base to which the foreign material is attached. There seems to be a regular succession of forms from *Astrorhiza,* in which there is a central chamber with many irregular openings to the tubular form open at both ends and of indefinite length, thence to the chamber closed usually except at a single point as *Proteonina* or with several apertures as in *Thurammina.* This single-chambered form then leads to the forms with a globular proloculum and an elongated chamber, but undivided. Occasionally tests are found as in *Rhabdammina discreta,* where there are external constrictions, but without complete divisions within.

### Subfamily 1. ASTRORHIZINÆ.

Test consisting usually of a tube open at both ends or in some species of *Astrorhiza* with several tubes entering a central chamber; in some species with the tube branching (*Rhabdammina irregularis, Rhizammina algæformis,* etc.).

Included in this subfamily are five genera, *Astrorhiza, Rhabdammina, Marsipella, Bathysiphon,* and *Rhizammina.* With the exception of the first we know very little concerning the animal, excepting for the material of which the test is made; each consists of a simple or branching tube open at the ends, except in some species of *Astrorhiza,* where there are several tubes and a single central chamber. The growth seems to take place by the addition of material at the open ends of the tube, thus increasing the length.

### Genus ASTRORHIZA Sandahl, 1857.

*Astrorhiza* SANDAHL (type, *Astrorhiza limicola* SANDAHL), Öfv. Svensk. Vet. Akad. Förh., vol. 14, no. 7, 1857, p. 299.—H. B. BRADY, Rep. Voy. *Challenger,* Zoology, vol. 9, 1884, p. 230.

*Astrorhiza*+*Rhabdammina* (part) EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 666.

*Ammodiscus* CARPENTER and JEFFREYS, Proc. Roy. Soc. London, 1870, p. 159 (not *Ammodiscus* REUSS, 1871).

*Arenistella* FISCHER and DEFOLIN, Les fonds de la mer, vol. 2, 1872, p. 26.

*Astrodiscus* F. E. SCHULZE, II Jahr. Comm. wiss. Unt. deutsch. Meer in Kiel, vol. 1, 1875, p. 113.

*Hæckelina* BESSELS, Jen. Zeitschr., vol. 9, 1875, p. 265.

*Description.*—Test free, flattened or tubular, composed of sand or mud loosely cemented; chamber within connecting with the exterior by the open ends of the tubes or by several definite apertures in the flattened forms.

Five species occur in the North Pacific, so far as is known. They are typically cold-water species here, as also in the North Atlantic. None of the species seem to be common so far as the material that has been examined shows.

### ASTRORHIZA ANGULOSA H. B. Brady.

*Astrorhiza angulosa* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 48; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 234, pl. 20, figs. 10–13.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 265, pl. 3, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 218, fig. 38 (in text).

*Description.*—Test depressed, subtriangular (rarely quadrangular), biconvex, rounded at the edges, interior consisting of a small central chamber from which tubes radiate, one to each angle of the test, their open ends serving as apertures; wall thickest about the central chamber, composed of fine sand, exterior of the test loose and granular, within, smoothly finished, wall about the apertures often tinged a reddish-brown.

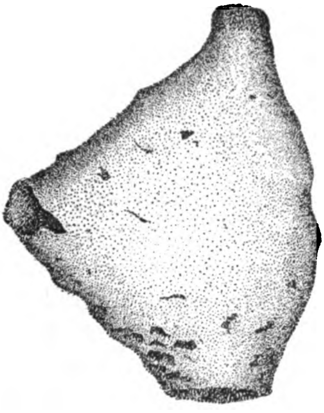


FIG. 1.—ASTRORHIZA ANGULOSA. × 15.

Diameter, 2–4 mm.

*Distribution.*—This species was obtained by the *Albatross* at a single station, D3407, off James Island, Galapagos, in 885 fathoms from globigerina ooze.

Of the four specimens from this station in Goës' material, two have the darker-colored neck as shown in Brady's figures (pl. 20, figs. 11, 12).

### ASTRORHIZA FURCATA Goës.

*Astrorhiza furcata* GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19, pl. 1, figs. 4, 5.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 218, fig. 39 (in text).

*Description.*—Test flattened below, convex above, triangular, with three tapering arms, attenuated at their ends, which serve as apertures; angles between the arms unequal, the arm opposite the smallest angle usually longer than either of the other two; wall of medium thickness, composed of mud and fine sand with occasional larger fragments; texture of wall fairly firm, more so than in most of the other species of the genus, color dark gray or almost black.

Length about 5 mm.

*Distribution.*—Obtained by the *Albatross* at a single station, D3419, off Acapulco, on the west coast of Mexico, in 772 fathoms in green mud. This is the type station.

The three specimens selected by Goës from the original station are figured here. They show the variation in form as well as other slight differences. One or two other specimens were also found in looking through the material from this station. The species is different in various ways from typical *Astrorhiza* but may be left here until more material can be obtained.

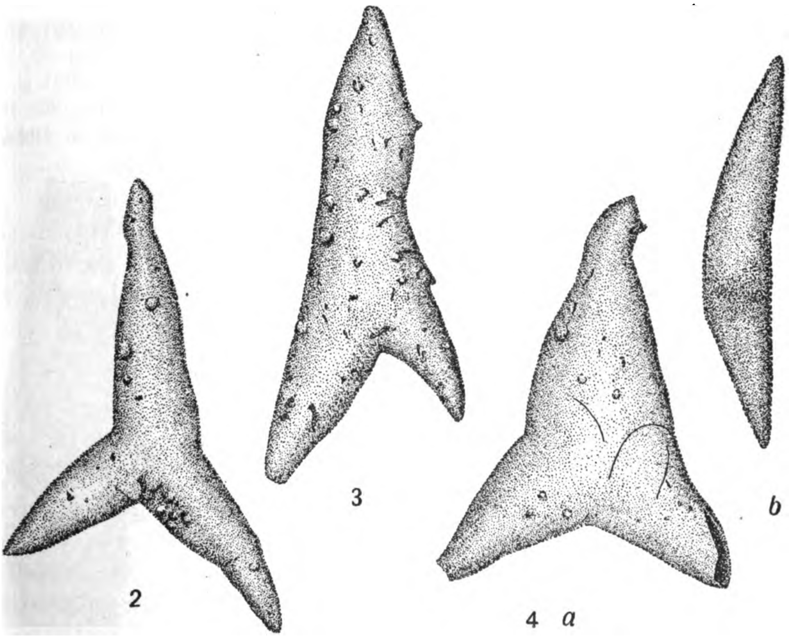
### ASTRORHIZA GRANULOSA (H. B. Brady).

*Marsipella granulosa* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 36, pl. 3, figs. 8, 9.—Bütschli, in Bronns, Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 194, pl. 5, fig. 9.

*Astrorhiza granulosa* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 48; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 234, pl. 20, figs. 14–23.—Neumayr, Stämme Thierreichs, vol. 1, 1889, p. 173, fig. 17*d*.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 265, pl. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 219, fig. 41 (in text).

*Rhabdammina granulosa* Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 667.

*Description.*—Test fusiform, tapering toward the ends, internally with a long tubular chamber of nearly uniform diameter, open at both ends, the apertures sometimes more or less closed by particles of sand; wall composed of fine siliceous sand, loosely cemented externally, occasionally with tests of *Globigerina* or other foreign particles cemented into the test, ends often with a brownish tinge, the rest of the test grayish.



Figs. 2-4.—Astrorhiza furcata. 2, 3, 4 *a*, face view of three specimens selected by Goës from the type station; 4 *b*, side view. × 10.

Maximum length, 5–7 mm.

*Distribution.*—I have had material of this species from four stations in the North Pacific. Of these one is the station recorded by Goës, *Albatross* station, D3375, southwest of Panama in 1,201 fathoms from globigerina ooze. The other three stations are in the Northwest Pacific, dredged by the *Albatross* in the 1906 cruise, D4979, 943 fathoms, D5031, 86 fathoms, and D5095, 58 fathoms. The first of these stations is in the southern portion of the Japan Sea, the other two being in shallow water south of Honshu Island, Japan.

The two stations from shallow water are in the influence of cold currents and this may account for the finding of this species at depths so much shallower than the previous records.

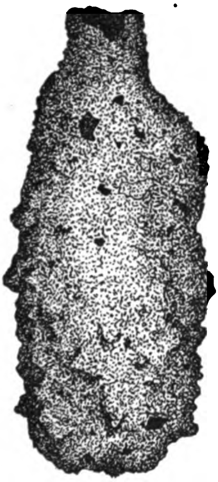


FIG. 5.—ASTRORHIZA GRANULOSA. × 10.

### ASTRORHIZA CRASSATINA H. B. Brady.

*Astrorhiza crassatina* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 47; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 233, pl. 20, figs. 1–9.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 13, pl. 2, figs. 11–15; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 19.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 265, pl. 2.—KIÆR, Norske Nordhavs-Exp., no. 25, 1899, p. 4.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 220, fig. 42 (in text).

*Rhabdammina crassatina* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.

*Description.*—Test subcylindrical or irregular, elongate, ends rounded, internally with a tubular chamber, open at both ends, but of uneven diameter, the apertures often more or less closed by particles of sand; walls thick, composed of fine sand, loosely cemented at the surface; occasionally with various foreign particles.

Maximum length of typical specimens, 8–10 mm.

*Distribution.*—Obtained by the *Albatross* at three stations in the 1906 cruise, D4946, 39 fathoms, D4949, 110 fathoms, and D4979, 943 fathoms. These three stations are near Japan—one south of Honshu Island, the other two southeast of Kiushu Island. All three of these are within the influence of the cold currents from the north. Goës records this species from *Albatross* station D3407, off James Island, Galapagos, in 885 fathoms from globigerina ooze.

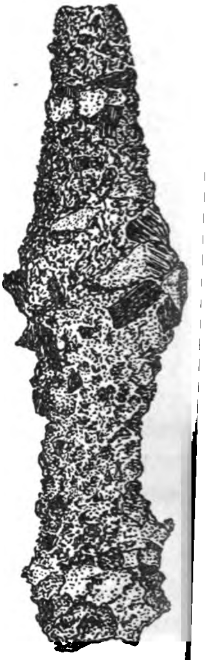


FIG. 6.—ASTRORHIZA CRASSATINA. × 10.

The specimens referred to this species by Goës are not typical. They are large, very rough, irregular tubes, with a very narrow and little dilated chamber, the longest specimen measuring nearly 25 mm. Just what these tubes are it is difficult to say, but their questionable position must simply be noted until living material can be studied.

### ASTRORHIZA TENUIS Goës.

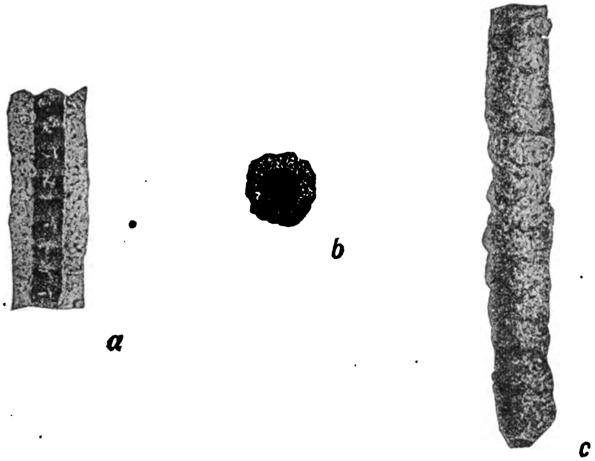
*Astrorhiza tenuis* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 20, pl. 1, figs. 6-8.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 220, fig. 43 (in text).

*Description.*—"More or less slender cylindrical or fusiformed tubes, usually tapering to the ends, with constricted apertures. Tube channel smooth, with faint traces of spurious septa. Wall loosely cemented of coarse sand, light grayish, comparatively thick."

"Length 5–10 mm.; diameter 1–1.5 mm."

*Distribution.*—Described by Goës from *Albatross* station D3431, 995 fathoms, at the entrance to the Gulf of California.

In the collection at Washington there are no specimens of this species in the material returned by Doctor Goës. No specimens which can be definitely assigned to this species were found in an examination of the unsorted material from this station. The description and figures are given from Goës's original paper. It seems to me questionable whether this is a true *Astrorhiza*, but without specimens it is difficult to decide.



Figs. 7.—Astrorhiza tenuis. *a*, longitudinal section; *b*, transverse section; *c*, side view of exterior. (After Goës.) × 6.

## Genus RHABDAMMINA Carpenter, 1869.

*Rhabdammina* M. Sars, Forh. Vid. Selsk. Christiania, 1868, p. 248 (*nomen nudum*).—W. B. Carpenter (type, *R. abyssorum* W. B. Carpenter), Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 288; Proc. Roy. Soc. London, vol. 18, 1869, p. 60.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 266.

*Astrorhiza* (part)+*Rhizammina* (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 666.

*Description.*—Test free, tubular, either straight, radiating from a common center or branching, open ends of the tube serving as apertures; wall coarsely arenaceous, usually more or less rough, firmly cemented.

This genus includes five species, four of which are now known from the North Pacific. As they are, as a rule, deep-water species, little is known concerning the soft parts. It seems likely that there is a more definite beginning to such a test as that of *R. irregularis* than has been seen. All the specimens have the appearance of being broken at the lower end.

### RHABDAMMINA ABYSSORUM W. B. Carpenter.

*Rhabdammina abyssorum* M. SARS, Forh. Vid. Selsk. Christiania, 1868, p. 248 (*nomen nudum*)—W. B. CARPENTER, Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 288; Proc. Roy. Soc. London, vol. 18, 1869, p. 60.—G. O. SARS, Forh. Vid. Selsk. Christiania, 1871, pp. 250, 251.—CARPENTER, The Microscope, 6th ed., 1881, pp. 562, 563, figs. 321 *c*, *d* (in text).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 266, pl. 21, figs. 1-13.—DE FOLIN, Le Naturaliste, vol. 9, 1887, p. 127, fig. 12*a*.—A. AGASSIZ, Bull. Mus. Comp. Zoöl., vol. 29, 1888, pp. 162, 163, figs. 492, 493 (in text).—NEWMAYR, Stämme Thierreichs, vol. 1, 1889, p. 173, fig. 17*a* (in text).—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 255, pl. 4, fig. 31.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 19, pl. 4, figs. 67, 68.—SCHLUMBERGER, Mém. Soc. Zool. France, vol. 7, 1894, p. 254.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 21.—KLÆR, Norske Nordhavs-Exp., no. 25, 1899, p. 4.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 271, pl. 12, fig. 2.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 264, fig. 108 (in text).

*Rhabdammina abyssorum*, var. *robusta* GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 143, pl. 12, figs. 430, 431.

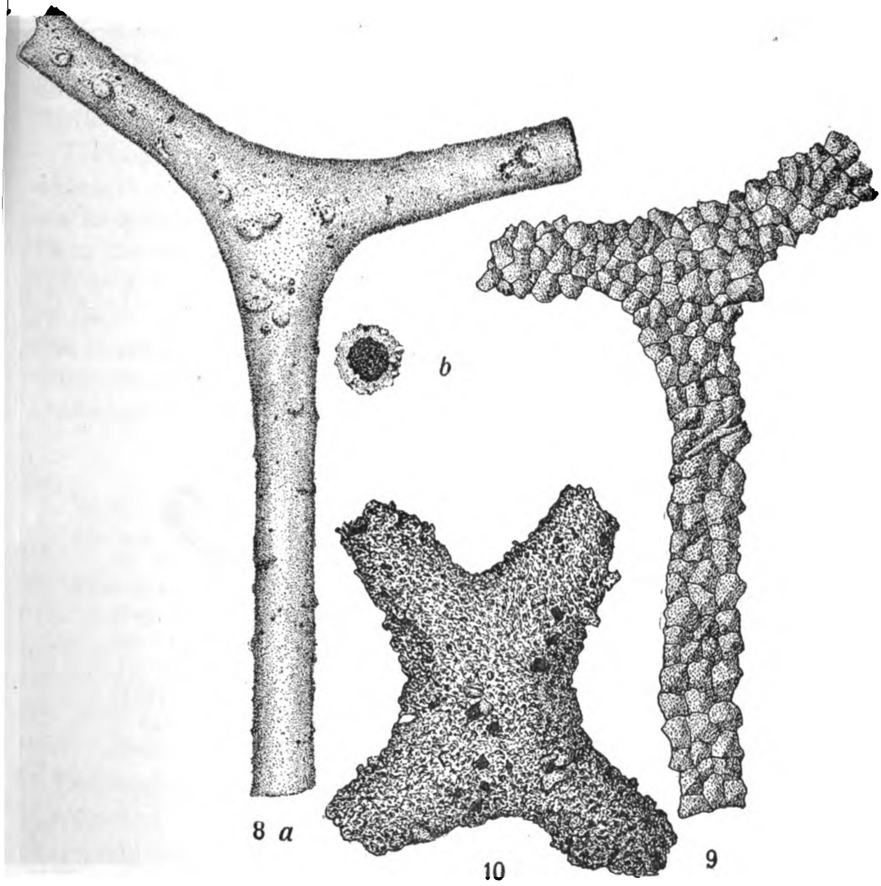
*Astrorhiza abyssorum* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 666.

*Description.*—Test free, consisting of a central chamber with three to five radiating arms, usually three, of nearly uniform diameter and usually in the same plane, but occasionally, when there are more than three arms, the extra ones may be in a different plane from the other three, arms tubular, circular in cross section, ends open, forming the apertures of the test, wall of the test composed of very firmly cemented sand grains of variable size, exterior usually roughened but the interior smooth, wall fairly thick, cement containing ferruginous material giving the test frequently a reddish brown color, but the color varies from light gray to almost black, according to the materials of which it is composed.

Diameter, including arms, up to 17 mm.

*Distribution.*—The species is well distributed in the North Pacific, occurring in at least fifteen of the *Albatross* and *Nero* stations. Of these, one is the station recorded by Goës, D3375, 1,201 fathoms off the west coast of Central America; it was very abundant at D4337, 617–680 fathoms off San Diego, California; one station is in Bering Sea, D3501, in 688 fathoms. The other twelve stations were in the region south of Japan in from 71–1,759 fathoms. The species was obtained by the *Challenger* at station 237, in 1,875 fathoms, east of Japan.

There is a considerable variation in this species along certain lines. Typically there are three arms, but there are occasionally four or five, these specimens usually being rare. However, at station D4337, off San Diego, California, there was obtained a considerable series of specimens of this species and among these examples with four or even five arms were rather common. In the matter of texture of the wall there is also a considerable variation, partly due to bottom conditions it would appear from the material examined. The specimens from shallower water are more apt to be constructed of coarse sand grains, figure 9, while those from deep water where such materials are lacking are made of much finer grains with more or less mud and often contain *Globigerina* or other tests in the wall. This species has been usually found in deep water, all but four stations being in water more than 600 fathoms deep.

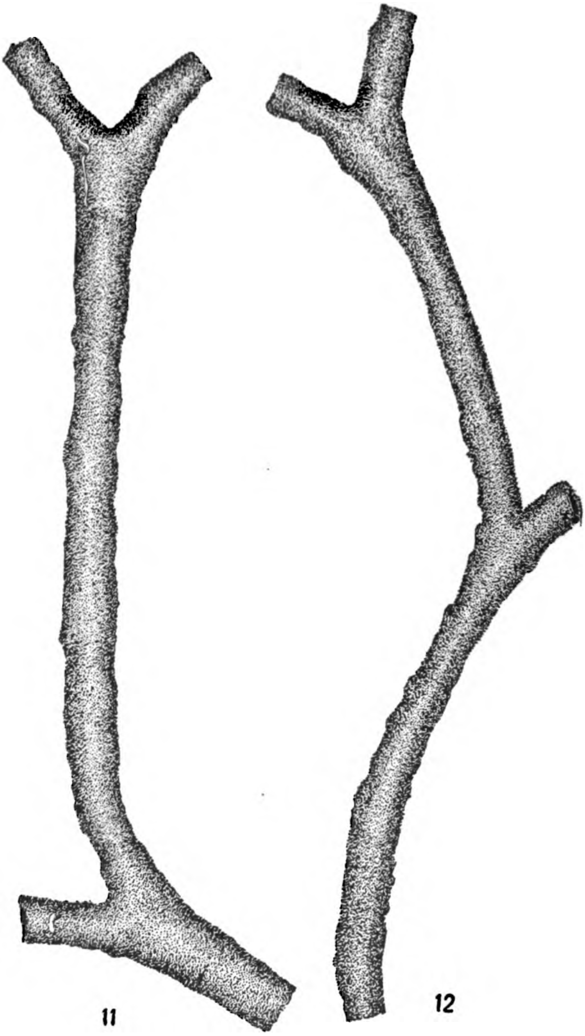


FIGS. 8-10.—RHABDAMMINA ABYSSORUM. 8*a*, FRONT VIEW; *b*, END VIEW OF ONE ARM OF THE SMOOTHER FORM FROM DEEP WATER, × 10; 9, FRONT VIEW OF A SHALLOW WATER SPECIMEN FROM THE COAST OF JAPAN, × 25; 10, CENTRAL PORTION OF A SPECIMEN WITH FOUR ARMS, × 15.

### RHABDAMMINA IRREGULARIS W. B. Carpenter.

*Rhabdammina irregularis* W. B. CARPENTER, Proc. Roy. Soc. London, vol. 18, 1869, p. 60.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 268, pl. 21, fig. 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 21.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 263, fig. 106 (in text).

*Description.*—Test made up of a dichotomously branching tubular chamber, of nearly even diameter, wall of firmly cemented sand grains, exterior rather rough, interior smoothly finished, ends of the tubes serving as the apertures, color usually a yellowish- or reddish-brown.



FIGS. 11-12.—TWO SPECIMENS OF RHABDAMMINA IRREGULARIS. × 6.

Length, up to 37.5 mm.

*Distribution.*—In the *Albatross* material from the west coast of Mexico and Central America this species forms what may be called "Rhabdammina bottom," being the most common constituent of the bottom in several places. In the material reported upon by Goës, it occurred at *Albatross* station D3392, in 1,270 fathoms off Panama, making up the mass of the dredged material. It also occurred in 995 fathoms at station D3431, at the entrance to the Gulf of California, in great quantity. These stations give all that is known of its distribution in the North Pacific, as it has not been noted in any of the other dredged material. At these stations *Rhabdammina abyssorum* seems to be lacking.

Throughout the mass of the material few specimens were found which in any way suggested completeness of the test. Where there is a long unbranched portion at the base it is usually somewhat curved. That there may be more than the two branches is shown by the figures given here. Just what the completed specimens are can not be definitely stated with the material at hand, but a considerable size is surely indicated. There seems to be a point of weakness just above the region of forking, and the great majority of specimens are broken at that point, as shown in the figure.

### RHABDAMMINA DISCRETA H. B. Brady.

*Rhabdopleura*, species, G. M. DAWSON, Can. Nat., vol. 5, 1870, p. 177, fig. 7.

*Rhabdopleura abyssorum* G. M. DAWSON, Amer. Journ. Sci., vol. 1, 1871, p. 206 fig. 7; Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86, fig. 7.

*Rhabdammina discreta* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 48; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 268, pl. 22, figs. 11–13.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 14.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 21, pl. 1, figs. 13, 14.—FLINT, Rep. U. S. Nat. Mus., 1897, (1899), p. 271, pl. 13.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 263, fig. 105 (in text).—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 125.

*Description.*—Test cylindrical, straight or nearly so, irregularly constricted at intervals, with the effect of divisions exteriorly but no corresponding walls within, open ends of the tube serving as apertures; wall rather thin, firmly cemented of angular sand grains, roughish on the exterior, but smoothly finished on the interior except at the constrictions, where there are various angles and irregularities; color varying with the material used in the construction of the wall.

Length indefinite, up to 25 mm.

*Distribution.*—*Rhabdammina discreta* has been found at six widely separated stations in the North Pacific. In the eastern portion it occurs at *Albatross* station D3419, in 772 fathoms, off the coast of Mexico in the material examined by Goës. Brady records its occurrence at one *Challenger* station in the western Pacific, west of the

Ladrone Islands, in 2,475 fathoms. The *Albatross* obtained this species at two stations in the 1906 cruise—D4979, in 943 fathoms, south of Honshu Island, Japan, and D5026, in 119 fathoms in the Okhotsk Sea. Bagg records the species from station H4502 in 1,342 fathoms near the Hawaiian Islands, but his specimen is a mere fragment, poorly characterized.

The specimen figured by Goës is not typical, but there are larger typical specimens among his mounted material from the same station. Brady speaks of the occurrence of this species usually at considerable depths, but in the far north off the coast of Greenland in 20 fathoms and in the far south off Kerguelen Island at 120 fathoms. He also gives a suggestion that the distribution may be more or less affected by the temperature of the ocean bottom. In this connection it is interesting to observe that the only North Pacific station for this species at all shallow, 119 fathoms, in the Okhotsk Sea, had a bottom temperature of 30.4° F., a low temperature even for ocean bottom conditions, colder even than the deeper stations where this species occurs.

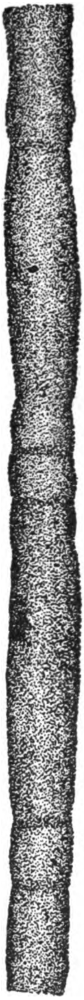


FIG. 13.—RHABDAMMINA DISCRETA. × 25.

### RHABDAMMINA LINEARIS H. B. Brady.

*Rhabdammina linearis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 37, pl. 3, figs. 10, 11.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 194, pl. 5, fig. 10.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 269, pl. 22, figs. 1–6.—A. AGASSIZ, Bull. Mus. Comp. Zoöl., vol. 29, 1888, p. 163, fig. 494 (in text).—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 18, pl. 4, figs. 65, 66.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 271, pl. 14, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 262, fig. 104 (in text).

*Description.*—Test free, elongate, straight or with the arms at an angle; central chamber of larger diameter than the two elongated tubular arms, wall of the central chamber thinner than that of the arms, composed of sand grains firmly cemented, apertures at the distal ends of the tubes; color variable, from whitish to brown according to the color of the sand of which it is composed.

Length 6–7 mm.

*Distribution.*—Brady records this species from the South Pacific, but in "The Summary of Results" of the *Challenger* expedition it is only given from two stations, 237 and 246, in 1,875 and 2,050 fathoms, one station east of Japan, the other in the middle of the North Pacific.

No typical example of this species was noted in the North Pacific material I have examined. Two specimens from *Albatross* station D4957, in 437 fathoms, may possibly belong here, but the central enlargement is not very pronounced.

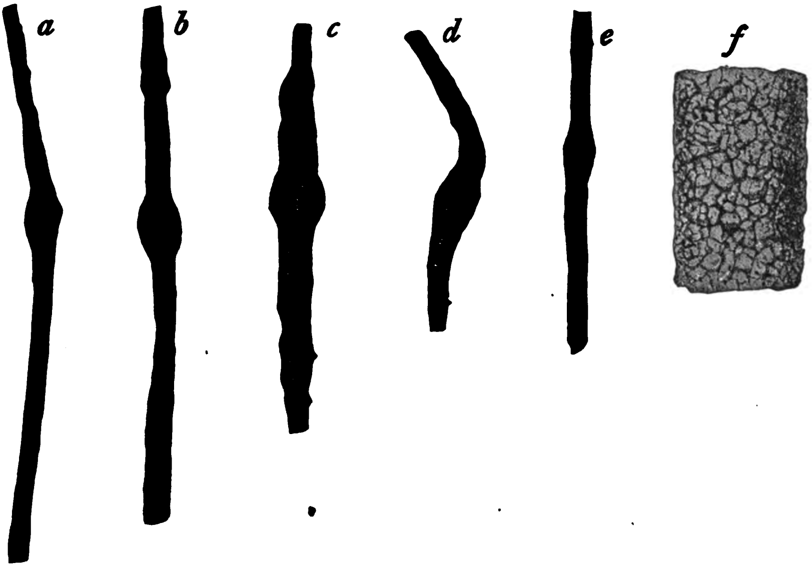


FIG. 14.—RHABDAMMINA LINEARIS. *a–e*, × 10, *e*, SHOWING INTERIOR, *f*, SURFACE. × 60. (AFTER BRADY.)

## Genus MARSIPELLA Norman, 1878.

*Marsipella* NORMAN (type, *M. elongata* NORMAN), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 281.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 264.

*Proteonina* W. B. CARPENTER, Proc. Roy. Soc. London, vol. 18, 1869, p. 60 (not *Proteonina* WILLIAMSON, 1858).

*Description.*—Test free, tubular, cylindrical or fusiform, sometimes recurved at the ends, apertures formed by the open ends of the tube, wall composed wholly or in part of sponge spicules, thin but firmly cemented together.

A single species has been found in the North Pacific, and that has occurred at but few stations. It has been found in the colder portions of the North Atlantic.

### MARSIPELLA CYLINDRICA H. B. Brady.

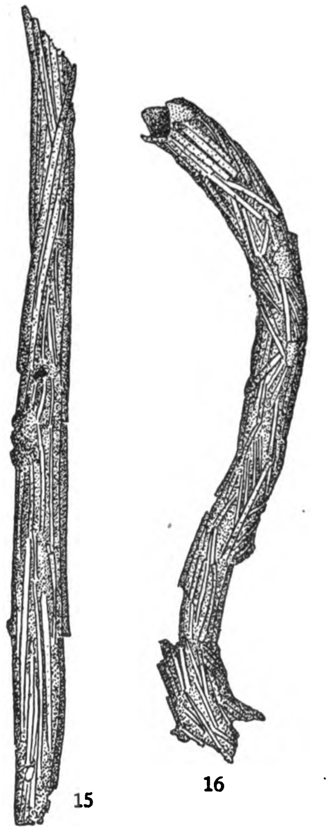
*Marsipella cylindrica* H. B. Brady, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 714; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 265, pl. 24, figs. 20–22.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 265, fig. 109 (in text).

*Description.*—Test tubular, slender, of nearly uniform diameter, ends of the tube open and serving as apertures, wall composed almost entirely of acicular sponge spicules, sometimes entire but usually in fragments, laid side by side, lengthwise of the test, and strongly cemented.

Length up to 7 mm.; diameter 0.12–0.25 mm.

*Distribution.*—As this genus has been recorded but once previously from the North Pacific, it is interesting to find it at four stations, but in small numbers. It has occurred off the Hawaiian Islands, *Albatross* station H3009, in 603 fathoms, rare. The other three stations are about Japan. They are, *Nero* station 1225, in 805 fathoms, south of Yokohama; *Albatross* stations D4957, in 437 fathoms, off the eastern coast of Kiushu Island, and D4900, in 139 fathoms, southwest of Nagasaki. The *Challenger* obtained it at station 237, in 1,875 fathoms, east of Japan.

The tubes are often tinged with a reddish-brown color as though the cement might contain ferruginous material. The wall is comparatively thin, but may be composed of several layers of spicules.



Figs. 15–16.—Marsipella cylindrica. × 30. 15, straight test composed largely of long unbroken spicules. 16, rougher, doubly curved test largely made up of fragmentary portions of spicules.

## Genus BATHYSIPHON G. O. Sars, 1871.

*Bathysiphon* G. O. Sars (M. Sars, in MS.) (type, *B. filiformis* G. O. Sars) Forh. Vid. Selsk. Christiania, 1871 (1872), p. 251.—Norman, Rep. Brit. Ass., 1880, pp. 389–390.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 248.—de Folin, Act. Soc. Linn. Bordeaux, vol. 40, 1886, p. 273.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 269.

*Description.*—Test free, cylindrical, sometimes tapering toward one end, straight or somewhat curved, often externally constricted, but without corresponding divisions of the tubular chamber internally, wall composed of sponge spicules overlaid by a varying thickness of what appears to be siliceous cement, wall thick in comparison with the diameter of the tube.

Two species of this genus have been found in the North Pacific, along the western coast of America, and again along the colder areas off the coast of Japan.

### BATHYSIPHON FILIFORMIS G. O. Sars.

*Bathysiphon filiformis* (M. SARS MS.) G. O. SARS, Forh. Vid. Selsk. Christiania, 1871 (1872), p. 251.—NORMAN, Rep. Brit. Ass., 1880, p. 389.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 248, pl. 26, figs. 15–20.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 16, pl. 3, figs. 39–41.—DE FOLIN, Act. Soc. Linn. Bordeaux, vol. 40, 1886, p. 279, pl. 6, figs. 4 *a–e*.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 12.—GOËS, Bull. Mus. Comp Zool., vol. 29, 1896, p. 23, pl. 1, figs. 11, 12.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 270, fig. 116 (in text).

*Description.*—Test free, cylindrical, of nearly uniform diameter, straight or somewhat curved, chamber tubular, of nearly uniform diameter, the open ends serving as the apertures; wall composed of felted sponge spicules and fine sand in varying proportions, rather soft; color light gray or white, sometimes even black, but when covered more or less by fine sand, taking on a brownish color.

Length up to 50 mm. or more; diameter up to 4 mm.

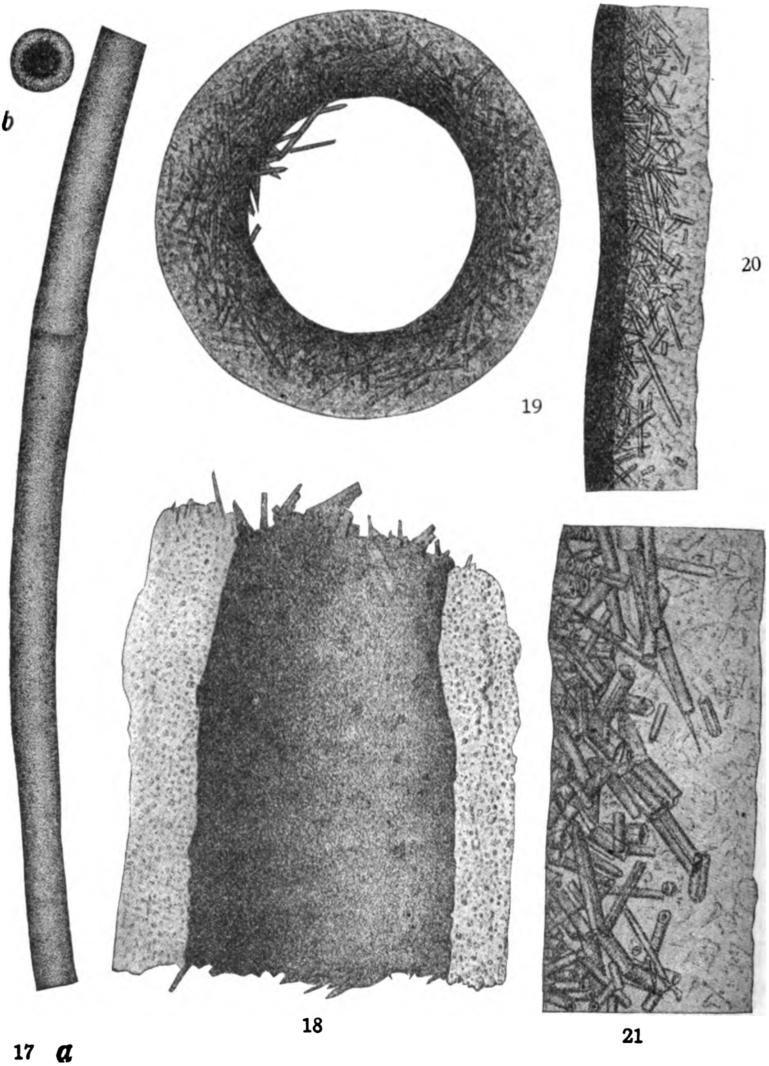
*Distribution.*—Specimens of this species were found by Goës in the *Albatross* material from the eastern tropical North Pacific at five stations, D3375, D3407, D3418, D3419, and D3431, in depths from 660–1,201 fathoms. I have examined Goës's material from Station D3419 and have found broken specimens in material from Station D3431. Later I obtained an abundance of fine long specimens from material dredged by the *Albatross* off San Diego, station D4337, 617–680 fathoms. These specimens were the best I have ever seen. The *Challenger* obtained specimens from station 237, in 1,875 fathoms, east of Japan.

Some of the specimens have a very considerable amount of arenaceous material built into the outer part of the wall, giving a very different appearance from that of typical specimens. These, however, are of the same size and shape and are associated in the material from the same station. In his list in 1896, page 92, Goës used the name, var. *arenosus* for this form with the sandy exterior, and his material has still another name, although neither was used in his original text. The constrictions of the wall are not prominent, as in the material figured by Brady.

Several fragmentary specimens were found at *Albatross* station D 5056, in 258 fathoms, in Suruga Gulf, Japan. These are somewhat smaller than the other material referred to and have a considerable range of variation in the character of the test.

### BATHYSIPHON RUFUS de Folin.

*Bathysiphon rufum* DE FOLIN, Act. Soc. Linn. Bordeaux, vol. 40, 1886, p. 283, pl. 6, figs. 8 *a–c*.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 23, pl. 1, fig. 10.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 267, pl. 7.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 270, fig. 118 (in text).



FIGS. 17-21.—BATHYSIPHON FILIFORMIS. 17, *a*, SIDE VIEW, × 4; *b*, END VIEW, × 5. 18, LONGITUDINAL SECTION, × 60. 19, TRANSVERSE SECTION, VIEWED BY TRANSMITTED LIGHT, × 60. 20, LONGITUDINAL SECTION OF WALL WITH EXTERIOR COAT, × 60. 21, LONGITUDINAL SECTION OF INNER PORTION OF WALL, × 200. (FIGS. 18-21. AFTER BRADY.)

*Description.*—Test free, elongate, tapering, slightly curved, surface with many irregularly placed constrictions, smooth and polished, wall comparatively thick, composed of sponge spicules and a very hard siliceous cement, color reddish or yellowish brown.

Length up to 12 mm.; diameter about 0.5 mm. in the broadest part.

*Distribution.*—Goës records this species from three *Albatross* stations, D3375, D3376, in 1,201 and 1,132 fathoms, respectively, south of Panama, near the equator; the other, D3419, in 772 fathoms, off Acapulco, on the Mexican coast. I have seen material from station D3376, consisting of eight specimens selected by Goës, and one of which is here figured. Specimens were also seen from station D 3407, just south of the equator, in this same region, in 885 fathoms. A single specimen was found in material from *Alert* station 1156, 2,046 fathoms, south of the Bonin Islands.

The specimens are much more constricted than those figured by de Folin, and none of them has the very small aperture or the finish shown in the larger end of the original specimens figured.

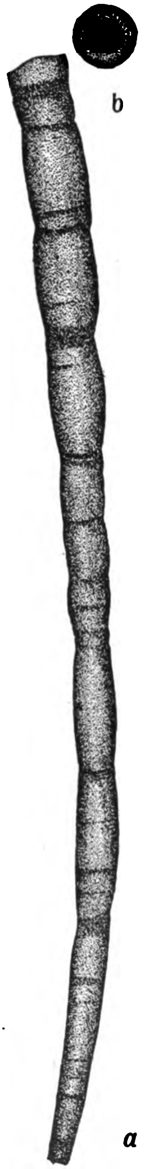


Fig. 22.—Bathysiphon rufus. × 20. *a*, side view; *b*, end view.

### Genus RHIZAMMINA H. B. Brady, 1879.

*Rhizammina* H. B. Brady (type, *R. algæformis* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 39.—Bütschli in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 195.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 274.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 252.

*Marsipella* (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.

*Description.*—Test free, consisting of a simple or dichotomously branching flexible tube, wall largely chitinous, bearing various foreign bodies attached to the exterior.

But two species of this genus are known, both occurring rarely in the North Pacific. The flexible character of the wall is a distinctive feature.

#### RHIZAMMINA ALGÆFORMIS H. B. Brady.

*Rhizammina algæformis* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 39, pl. 4, figs. 16, 17; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 274, pl. 28, figs. 1-11.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 20.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 272, pl. 15, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 252, fig. 92 (in text).

*Description.*—Test free, consisting of a dichotomously branching flexible tube, forming tangled masses of indefinite size; wall thin, largely chitinous, but with various sorts of foreign matter attached to the exterior, either sand or other foraminiferal tests according to the character of the bottom, surface when free from foreign matter roughened, color of the chitinous tubes brown.

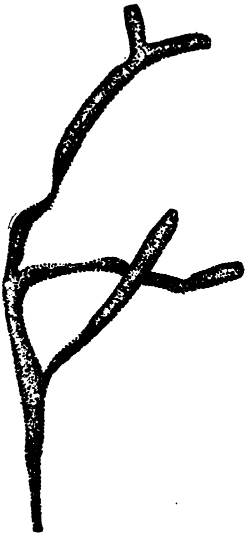


FIG. 23.—RHIZAMMINA ALGÆFORMIS. × 10.

Diameter 0.126–0.315 mm.

*Distribution.*—But four stations are known in the North Pacific for this species. Three of these are *Challenger* stations, 237, 244, 246, in 1,875, 2,900 and 2,050 fathoms, respectively; two in the middle of the North Pacific, the shallowest one east of Japan. Goës found the species at *Albatross* station D3415, off the coast of Mexico, in 1,879 fathoms. This material of Goës which I have examined is typical, without any appreciable amount of foreign material adherent to the tubes.

As the experiments of Brady show, the test is very largely made up of chitinous material with a small amount of silica in the wall.

### RHIZAMMINA INDIVISA H. B. Brady.

*Rhizammina indivisa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 277, pl. 29, figs. 5–7.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 256, pl. 4, fig. 17.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 14.—GOËS, Bull. Mus. Comp. Zoöl. vol. 29, 1896, p. 20.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 272, pl. 15, fig. 2.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 252, fig. 91 (in text).

*Marsipella indivisa* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 668.

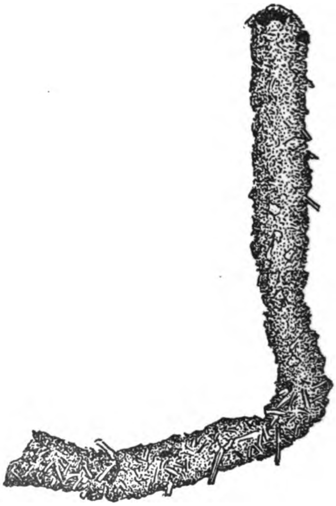


FIG. 24.—RHIZAMMINA INDIVISA. × 20.

*Description.*—Test free, cylindrical, flexible, often tapering toward the ends, which are open and serve as apertures, wall composed largely of chitinous material but with a variable amount of sand or foraminiferal tests attached to the exterior.

Length up to 10 mm.; diameter 0.25–0.40 mm.

*Distribution.*—The only previously recorded station for this species in the North Pacific is *Albatross* station D3375 in 1,201 fathoms in globigerina ooze southwest of Panama. Goës's material consists of six specimens from this station. Some of them are not this species but belong evidently to *Pelosina cylindrica* H. B. Brady. Fragmentary material referred to this species has been noted in the samples from three *Nero* stations between Midway Island and Guam, Nos. 172, 1583, and 1678, in 2,086, 777, and 1,283 fathoms, respectively, all in globigerina ooze.

## Subfamily 2. SACCAMMININÆ.

Test consisting of a single chamber, or group of superficially attached chambers, the walls made up for the most part of agglutinated material; apertures sometimes numerous but usually single; tests free or attached.

Included here are a number of genera which seem to have certain common characters; that of a test of agglutinated material of a single chamber, usually with a single opening. The wall may be greatly varied in its constituents in the various genera, being composed of sand grains in *Proteonina*, of a single layer of sponge spicules in *Technitella*, of a felted mass of spicules in *Pilulina*, or of other tests, etc., in *Pelosina cylindrica.*

### Genus PSAMMOSPHÆRA F. E. Schulze, 1875.

*Psammosphæra* F. E. Schulze (type, *P. fusca* F. E. Schulze), II Jahr. Comm. wiss. Unt. deutsch. Meer in Kiel, 1875, p. 113.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 202.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 249.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 267.—Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 598.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 241.

*Saccammina* (part) Rhumbler, Zeitschr. wiss. Zool. vol. 57, 1894, p. 462; Nachr. kön. Ges. Wiss. Göttingen, 1895, pp. 81, 82.

*Description.*—Test free or attached, usually spherical, no definite aperture, the pseudopodia making their way out between the elements of the test; wall composed of sand grains or other loose material cemented together.

Two species of this genus occur in the North Pacific, but both of them are rare and have been found at but few stations.

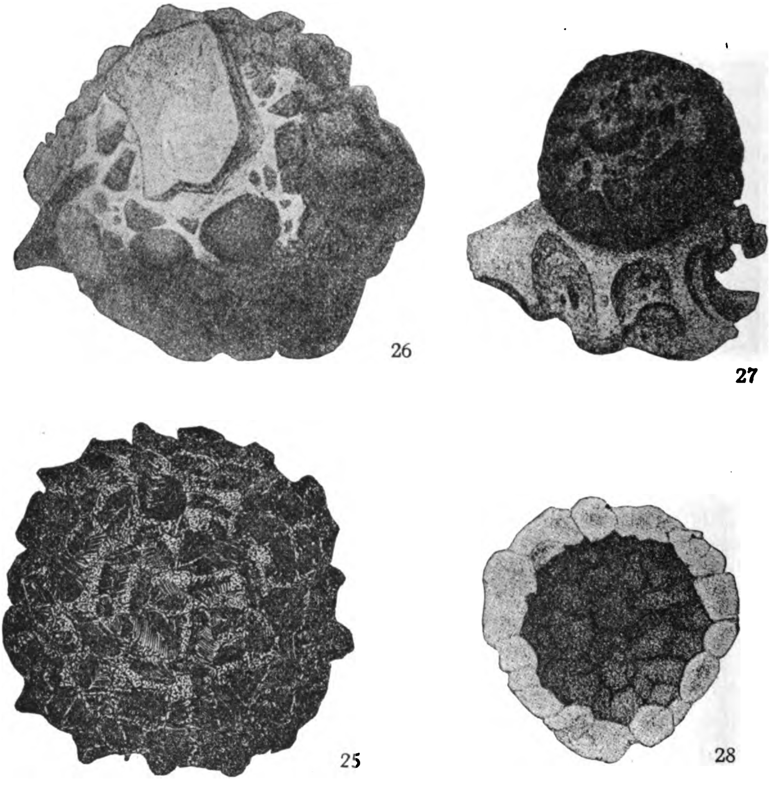
#### PSAMMOSPHÆRA FUSCA F. E. Schulze.

*Psammosphæra fusca* F. E. Schulze, II Jahr. Comm. wiss. Unt. deutsch. Meer in Kiel, 1875, p. 113, pl. 2, figs. 8 *a-f.*—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 249, pl. 18, figs. 1, 5–8 (not 2–4).—Goës, Kongl. Svensk. Vet. Akad. Handl, vol. 25, no. 9, 1894, p. 14, pl. 3, fig. 19.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 268, pl. 8, fig. 1.—Millett, Journ. Roy. Micr. Soc., 1899, p. 251.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 242, fig. 75 (in text).—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 1, pl. 1, fig. 1.

*Description.*—Test free or attached, generally spherical, no definite aperture: wall composed of a single layer of rather coarse sand grains, rather roughly put together, cement gray or brownish.

Diameter 1.5–4 mm.

*Distribution.*—Brady records this species from but two *Challenger* stations in the North Pacific, in 1,850 and 1,875 fathoms, west of the Caroline Islands, and west of Japan. Flint records it at one *Nero* station, No. 152, in 3,026 fathoms, east of Midway Island. I have specimens from two other *Nero* stations, Nos. 1153 and 1315, in 1,932 and 1,494 fathoms, near the Bonin Islands in the Western Pacific.



FIGS. 25–28.—PSAMMOSPHÆRA FUSCA. 25, SPECIMEN COMPOSED OF BLACK VOLCANIC SAND, × 25. 26, FREE SPECIMEN, × 20. 27, ATTACHED SPECIMEN, ×40. 28, SECTION OF TEST, × 40. (FIGS. 26–28. AFTER BRADY.)

### PSAMMOSPHÆRA PARVA Flint.

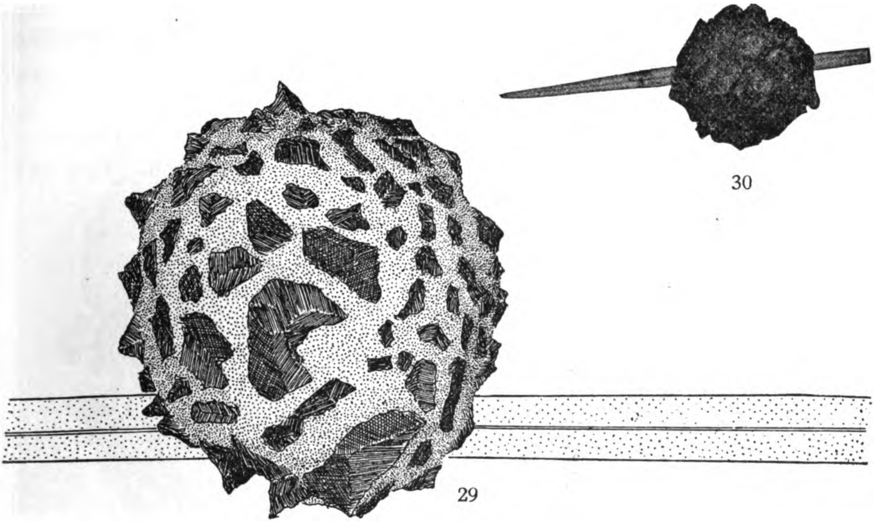
*Psammosphæra parva* FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 268, pl. 9, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 242, fig. 77 (in text).

*Psammosphæra fusca* (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 250, pl. 18, figs. 2–4 (not 1, 5–8).

*Description.*—Test free or attached, often attached to or inclosing a sponge spicule, spherical, if free, or frequently with a flattened area when attached, no definite aperture, wall thin, composed of fine sand, the particles firmly united by an abundance of cement which fills up the interstices to a large extent, color grayish or brown.

Diameter usually less than 1 mm.

*Distribution.*—Specimens which seem to be referable to this species have been noted at three stations in the North Pacific—*Albatross* station H2899 in 1,531 fathoms, east of the Hawaiian Islands, and D4979 in 943 fathoms, south of Honshu Island, Japan, also *Nero* station 1321, in 1,618 fathoms near the Bonin Islands.



FIGS. 29–30.—PSAMMOSPHÆRA PARVA. 29, SPECIMEN ATTACHED TO LARGE SPONGE SPICULE, × 50. 30, SMALLER SPECIMEN (AFTER BRADY), × 40.

There seems to be some variation in color in the specimens and the degree to which the cement fills the irregularities of the wall.

### Genus SOROSPHÆRA H. B. Brady, 1879.

*Sorosphæra* H. B. Brady (type, *S. confusa* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 28; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 251.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 235.

*Description.*—Test consisting of a colony of more or less inflated chambers, without definite apertures, the walls joined to one another, composed of sand grains with interstitial openings.

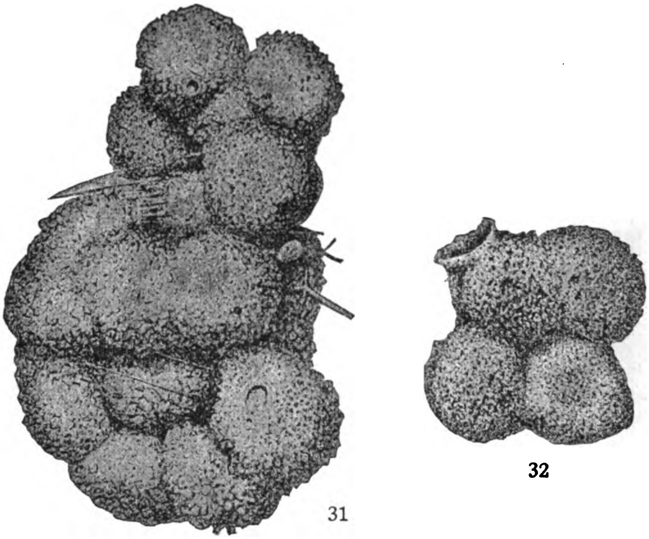
The following species has been recorded from the North Pacific by Brady:

#### SOROSPHÆRA CONFUSA H. B. Brady.

*Sorosphæra confusa* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 28, pl. 4, figs. 18, 19; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 251, pl. 18, figs. 9, 10.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 235, fig. 63 (in text).

*Description.*—"Test free, consisting of a number of inflated or spherical chambers of nearly uniform size, irregularly crowded together and adhering to each other by their outer surfaces. Walls thin, finely arenaceous in texture, with minute interstitial orifices. General aperture wanting. Diameter of individual chambers about one-twenty-fifth of an inch (1 mm.), of the entire colony, variable, sometimes one-sixth of an inch (4.5 mm.)."

*Distribution.*—Brady records this species at one *Challenger* station, 244, in the middle of the North Pacific in 2,900 fathoms. In the volume on "Summary of Results" this species is also given as occurring at station 246, in 2,050 fathoms. This station is also in mid-ocean.



Figs. 31-32.—Sorosphæra confusa. × 15 (after Brady).

The species has not been noted in any of the *Albatross* or *Nero* material I have examined from the North Pacific. The above description and figure 8 are from Brady.

### Genus SACCAMMINA Carpenter, 1869.

*Saccammina* (M. Sars type, *S. sphærica* G. O. Sars, Forh. Vid. Selsk. Christiania, 1868 (1869), p. 248) [*nomen nudum*].—Carpenter, Ann Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 289.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 195.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 252.—Rhumbler, Zeitschr. wiss. Zool., vol. 57, 1894, p. 462.—Eimer and Fickert (part), Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 242.

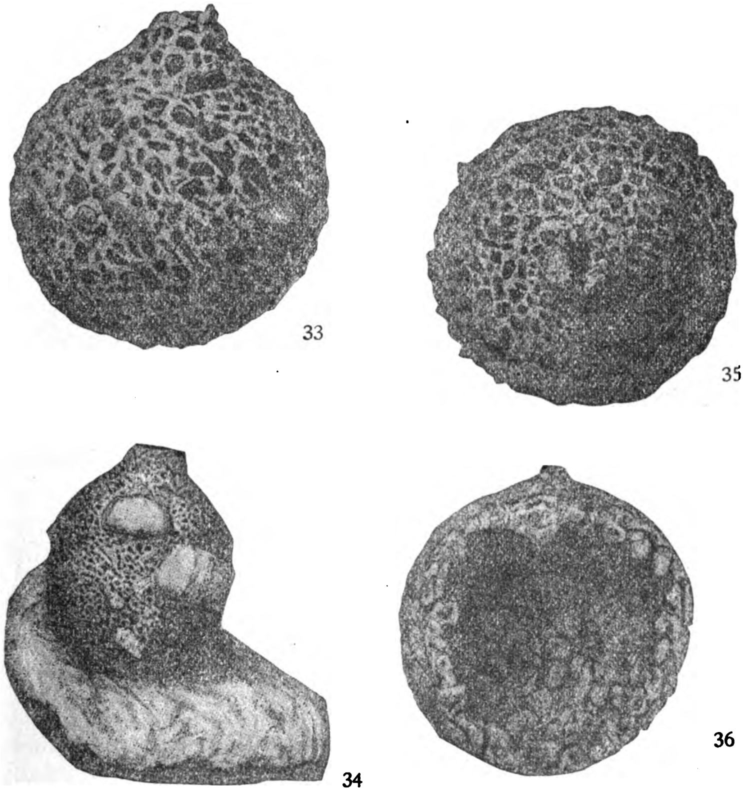
*Description.*—Test free, or sometimes attached, of one or several spherical chambers with distinct apertures, usually one for each chamber, wall composed of sand grains attached firmly to one another by a yellowish or brownish cement.

Two species of *Saccammina* occur in the North Pacific. The first of these, *S. sphærica,* has been found at numerous stations in the colder waters, but the other species, *S. socialis,* seems to be very rare.

### SACCAMMINA SPHÆRICA G. O. Sars.

*Saccammina sphærica* (M. Sars, Forh. Vid. Selsk. Christiania, 1868 (1869), p. 248, *nomen nudum*), G. O. Sars, Forh. Vid. Selsk. Christiania, 1871, p. 250.—Carpenter, The Microscope, 5th ed., 1875, p. 532, fig. 272*a–c*.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 253, pl. 18, figs. 11–17.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 254, pl. 4, fig. 8.—Rhumbler, Zeitschr. wiss. Zool., vol. 57, 1894, pp. 433–619, pls. 21–25.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 13, pl. 3, figs. 16–18.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 26.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 269, pl. 9, fig. 2.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 243, figs. 78*a–d* (in text).

*Description.*—Test free, rarely attached, spherical or pyriform; typically of a single chamber with a single aperture at the end of a slightly projecting portion of the test; wall composed of fairly coarse sand grains, firmly cemented; color various, gray to almost black, occasionally brownish or reddish.



Figs. 33–36.—Saccammina sphærica. × 15 (after Brady). 33, free specimen. 34, attached specimen. 35, apertural view. 36, section.

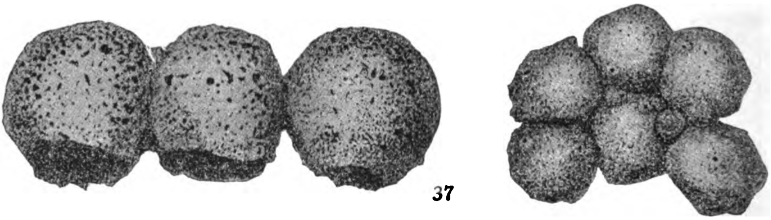
Diameter 1–3.5 mm.

*Distribution.*—This species appears to be fairly well distributed in the North Pacific in the colder waters. The *Challenger* dredged specimens at station 246 in 2,050 fathoms in the middle of the North Pacific. Goës records it from three *Albatross* stations off the coast of Mexico in 660–995 fathoms. His selected material which I have seen, from the entrance to the Gulf of California, is very large and more like the typical Arctic material. I have found the species in material in 2,085 fathoms, *Albatross* station H2833, midway between San Francisco and the Hawaiian Islands; also from several stations south of Japan in the colder water, in 139–1,551 fathoms.

### SACCAMMINA SOCIALIS H. B. Brady.

*Saccammina socialis* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 255, pl. 18, figs. 18, 19.—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 244, fig. 79 (in text).

*Description.*—"Test consisting of several independent arenaceous chambers, individually spherical or subspherical in shape and of nearly even size, attached to each other by their outer surfaces, but without stoloniferous intercommunication, each chamber having its own external aperture. Spheres seldom more than six or eight in number, and usually arranged with more or less regularity. Texture finely sandy, nearly smooth externally. Diameter of the individual chambers, one-thirtieth of an inch (0.8 mm.) or less."



Figs. 37–38.—Saccammina socialis. × 20 (after Brady).

*Distribution.*—Brady described this species from *Challenger* station 246, 2,050 fathoms, in the middle of the North Pacific. I have seen no material of this species in all the North Pacific material examined. The figures and description are from the originals of Brady.

## Genus PROTEONINA Williamson, 1858.

*Proteonina* Williamson (type, *P. fusiformis* Williamson), Recent Foraminifera of Great Britain, 1858, p. 1 (not *Proteonina* Terquem, 1875).—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 244.

*Reophax* (part) H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 199.

*Reophax* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82.

*Difflugia* Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1895, p. 251 (not *Difflugia* Leclerc, 1815).

*Saccammina* (part) Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.

*Description.*—Test free, consisting of a single chamber, flask-shaped or fusiform with a single aperture, wall composed of coarse sand grains or other foreign matter, test usually broadest near the base and gradually tapering more or less evenly to the apertural end.

Several species of *Proteonina* occur in the North Pacific, certain of the species apparently confined to specific regions as far as the material is able to indicate.

### PROTEONINA FUSIFORMIS Williamson.

*Proteonina fusiformis* WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 1, pl. 1, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 248, fig. 84 (in text).

*Reophax fusiformis* H. B. BRADY, Denkschr. kais. Akad. Wiss. Wien, vol. 43, pt. 2, 1882, p. 99; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 290, pl. 30, figs. 7-11.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 253, pl. 4, fig. 11.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 125.

*Lituola fusiformis* J. WRIGHT, Rep. Belfast Club, 1876-77, Append., table.

*Lituola nautiloidea*, var. *scorpiurus* W. B. CARPENTER, in Parker and Jones, Intr., Study Foram. 1862, Append., p. 309.

*Description.*—Test free, fusiform, asymmetrical, chamber either single or somewhat incompletely divided, walls composed of fairly coarse sand grains, rough externally, but closely cemented, aperture terminal, single.

Length 0.63-1.0 mm. or more.

*Distribution.*—This species does not seem to be common in the North Pacific, but four stations being known. The *Challenger* found it near the Philippines, Station 209, 95 fathoms. Doctor Bagg records it from the Hawaiian Islands, *Albatross* station H4585, 689 fathoms. It has also been noted from two *Nero* stations in the vicinity of the Bonin Islands, in 1,415 and 1,543 fathoms.

Specimens of this species are always more or less irregular in form, but the general character of Williamson's figure is readily distinguished in the specimens.

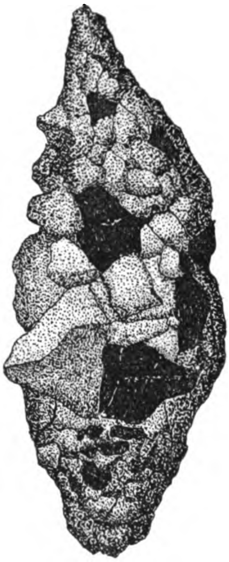


FIG. 39.—PROTEONINA FUSIFORMIS. × 75.

### PROTEONINA DIFFLUGIFORMIS (H. B. Brady).

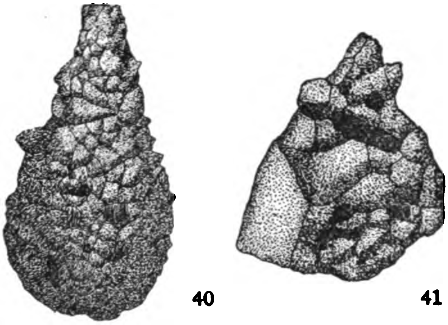
*Reophax difflugiformis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 51, pl. 4, figs. 3 *a*, *b*; Denkschr. kais. Akad. Wiss. Wien, vol. 43, pt. 2, 1882, p. 99; Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289, pl. 30, figs. 2-4 (not 1, 5).—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 26, pl. 6, figs, 196-198; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 28.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 272, pl. 16, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 252.

*Saccammina difflugiformis* EIMER and FICKERT, Zeitschr. wiss. Zool., vol 65, 1899, p. 671.

*Proteonina difflugiformis* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 245, figs. 80 *a*, *b*, (in text).

*Description.*—Test free, consisting of a single elongate oval or pyriform chamber, with a more or less distinct tubular neck; chamber undivided; wall fairly thick, composed of closely cemented sand grains of variable size and roughness; aperture simple, terminal; color, varying with the material of the wall.

Length 0.36–0.75 mm.



FIGS. 40–41.—PROTEONINA DIFFLUGIFORMIS. 40, A TYPICAL ELONGATE SPECIMEN OF FINE SAND GRAINS. × 80. 41, AN IRREGULAR SPECIMEN WITH LARGER SAND GRAINS, THE LARGE FRAGMENTS AT THE LEFT CAUSING A DISTORTION OF THE OUTLINE OF THE TEST. × 50.

*Distribution.*—The various records for this species are all in rather cold or deep water as far as the North Pacific is concerned. Brady records it in the deep water of the Northwest Pacific, in 2,300–3,950 fathoms. Goës found the species in material from off the west coast of Mexico and southwest of Panama, *Albatross* stations D3415 and 3376 in 1,879 and 1,132 fathoms, respectively. I have examined Goës's material from the latter station.

Specimens referable to this species have been found in the *Albatross* material from the Northwest Pacific, stations D4957, D4979, and D5095, in 437, 943, and 58 fathoms, respectively. These stations are in the cold area off the southeast coast of Japan.

### PROTEONINA DIFFLUGIFORMIS (H. B. Brady), var. LAGENARIUM (Berthelin).

*Haplophragmium lagenarium* BERTHELIN, Mém. Soc. Géol. France, vol. 1, no. 5, 1880, p. 21, pl. 24, fig. 2.

*Reophax difflugiformis* (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289, pl. 30, figs. 1, 5 (not 2–4).

*Reophax difflugiformis*, var. *lagenarium* MILLETT, Journ. Roy. Micr. Soc., 1899, p. 253, pl. 4, fig. 8.

*Proteonina difflugiformis-lagenarium* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 247, fig. 80 *c* (in text).

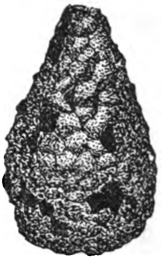


FIG. 42.—PROTEONINA DIFFLUGIFORMIS, VAR. LAGENARIUM. × 75.

*Description.*—Variety differing from the typical by lacking the distinction between body and neck; elongate, exterior rough, usually smaller than the typical and more nearly cylindrical.

Length about 0.25–0.40 mm.

*Distribution.*—This variety has been noted at but two stations in the North Pacific, occurring at *Nero* station 1444, in 2,175 fathoms, near Guam, Ladrone Islands, and at *Albatross* station D4967, 244 fathoms, off Japan.

### PROTEONINA OVATA, new species.

*Description.*—Test free, ovate in side view, nearly circular in end view, wall thick, composed of neatly cemented and fairly large sand grains, apertural end abruptly contracted to form a short, tapering neck with the very small aperture at its extremity; color light yellowish or brownish gray; fairly large

Length about 1.25 mm.; diameter about 0.6 mm.

*Distribution.*—Specimens of this species have been seen in material from but two stations, *Albatross* H3007, in 323 fathoms, and Nero station 2071, in 271 fathoms, both near the Hawaiian Islands.

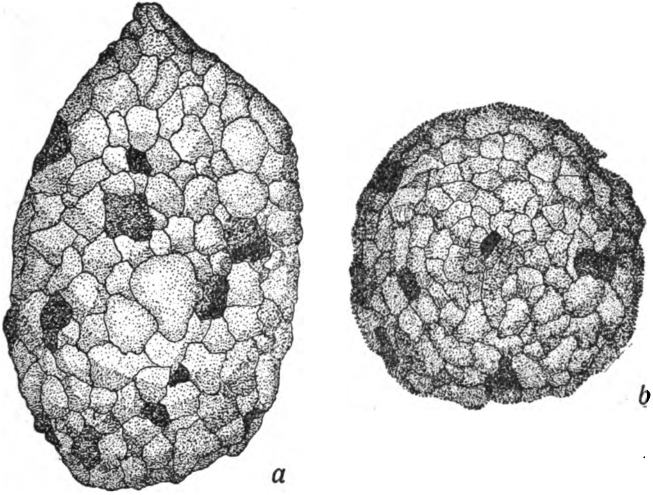


FIG. 43.—PROTEONINA OVATA. × 50. *a*, FRONT VIEW; *b*, APERTURAL VIEW.

*Type-specimen.*—Cat. No. 8264, U.S.N.M., from *Nero* station 2071.

The species is a fairly large one. The form, abrupt contraction of the neck with the very small aperture, will at once distinguish this from other described species.

## Genus PILULINA W. B. Carpenter.

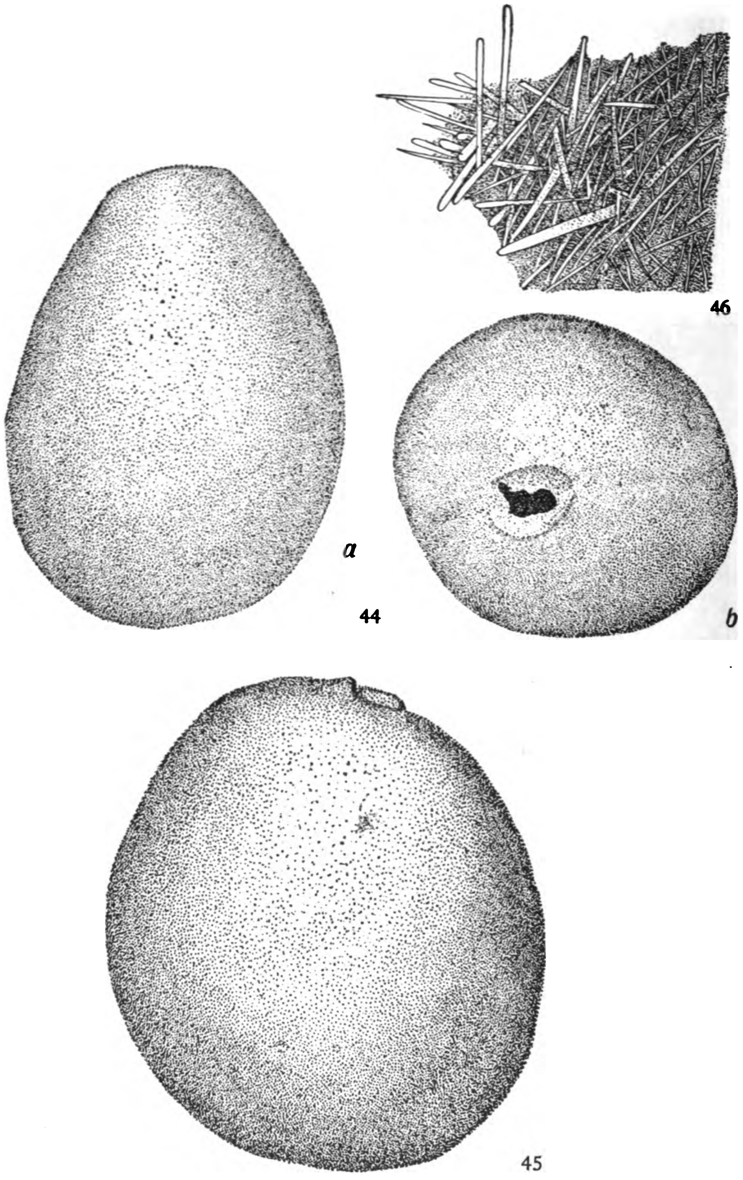
*Pilulina* W. B. CARPENTER, (type, *P. jeffreysii* W. B. CARPENTER.) Descr. Cat. Objects Deep-Sea Dredging [1870], p. 5.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 244.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 249.

*Description.*—Test free, globular or ovate, consisting of a single undivided chamber, wall composed of felted sponge spicules and a slight amount of fine sand without cement, aperture elongate, with a somewhat depressed area about it.

A single species was described by Carpenter from the North Atlantic. A new species has been found in material dredged by the fisheries steamer *Albatross* north of Japan differing in certain characters from the species described by Carpenter. The wall of these species is rather unique, as no cement seems to be used, the long spicules being felted together into a thin wall.

### PILULINA OVATA, new species.

*Description.*—Test ovate in side view, broadly elliptical or nearly circular when viewed from the apertural end; walls very thin, smooth, composed of felted sponge spicules and fine amorphous material;



Figs. 44–46.—Pilulina ovata. 44, *a*, side view of one of the small specimens, × 20; *b*, same from the apertural end. 45, a large specimen from the side. × 12. 46, a portion of the wall by transmitted light. × 100.

aperture irregular in shape, elongate, situated in an oval depression at the smaller end of the test; color white.

Largest specimens 5 mm. in length; 3 mm. in diameter.

*Distribution.*—A number of specimens of this species were obtained by the fisheries steamer *Albatross* on the 1906 cruise in the Northwest Pacific. They are from station D5056, in 258 fathoms, in Suruga Gulf, Japan.

*Type-specimen.*—Cat. No. 8257, U.S.N.M., from the above station.

This species differs from *Pilulina jeffreysii* Carpenter in its general form, in its very thin walls, and in the character of its aperture. It may belong to a new genus as it differs in characters of rather more than specific importance. *Pilulina jeffreysii* is only known from the North Atlantic and this species is widely separated geographically as well as by distinctive characters.

### Genus PELOSINA H. B. Brady, 1879.

*Pelosina* H. B. BRADY (type, *P. variabilis* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 30.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 194.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 235.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 238.

*Description.*—Test free, variously formed, rounded, cylindrical or irregularly elongate; wall usually thick, composed of mud with a chitinous basal layer, exterior often with various foreign bodies included in the test; aperture typically single and terminal.

Three species of *Pelosina* are known from the North Pacific, but all of them seem to be rare, and for the most part they occur in deep water.

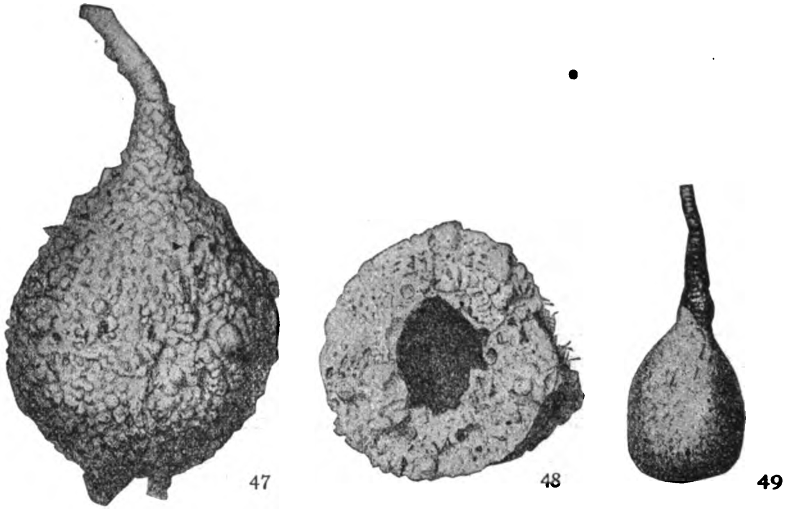
#### PELOSINA ROTUNDATA H. B. Brady.

*Pelosina rotundata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 31, pl. 3, figs. 4, 5; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 236, pl. 25, figs. 18–20.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 254, pl. 11, fig. 60.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 249, pl. 1, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 239, fig. 71 (in text).

*Description.*—Test flask-shaped or pyriform with an elongated tubular neck, at the end of which is the aperture; wall thick, composed of mud and the tests of other Foraminifera, *Globigernia*, etc., with little cement, the tubular neck membranaceous, interior consisting of a single undivided chamber, small; color grayish white.

Diameter 1.8 mm.

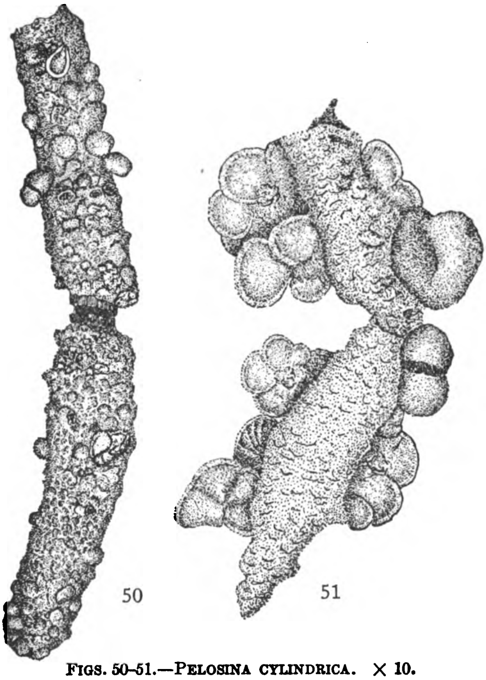
*Distribution.*—The *Challenger* dredged this species at station 246, in 2,050 fathoms in the middle of the North Pacific. This is the only record for this area, although it was found by Millett in material from the Malay Archipelago. It has usually been found in rather deep water.



FIGS. 47–49.—PELOSINA ROTUNDATA. × 20 (AFTER BRADY). 48, TRANSVERSE SECTION.

### PELOSINA CYLINDRICA H. B. Brady.

*Pelosina cylindrica* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 236, pl. 26, figs. 1–6.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 253, pl. 4, figs. 1, 2.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 239, fig. 72 (in text).



FIGS. 50–51.—PELOSINA CYLINDRICA. × 10.

*Description.*—Test elongate, cylindrical, straight or slightly curved, of nearly uniform diameter, ends rounded, aperture at one end, circular; wall thick, composed of loosely aggregated shell fragments or foraminiferal tests with a mud base, outside irregular, rough, interior smoothly finished, interior chitinous; color dark gray, but varying much according to the constituents of the test, being almost white when many foraminiferal tests are included in the wall.

Length up to 12 mm.; diameter about 2 mm.

*Distribution.*—The *Challenger* expedition obtained this species at three North Pacific stations, 237, 244, 246, in

1,875–2,900 fathoms. These stations are in the deep portion of the western Pacific, the first of the stations off the east coast of Japan.

The only *Albatross* material I have seen which may be referred to this species is a portion of the specimens selected by Goës from *Albatross* station D3375, in 1,201 fathoms, in the eastern tropical Pacific. These were all called by Goës *Rhizammina indivisa*, but some of them evidently belong here.

### PELOSINA VARIABILIS H. B. Brady.

*Pelosina variabilis* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 30, pl. 3, figs. 1–3; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 235, pl. 26, figs. 7–9.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 266, pl. 4, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 239, fig. 74 (in text).

*Description.*—Test consisting of a single fusiform chamber, or of two or three independent chambers, irregularly associated, but usually at the apertural end of the first chamber; wall thick, composed of mud and some foreign particles loosely aggregated, the basal layer being chitinous, apertural end somewhat extended into a tubular neck, the wall of which is membranaceous, at its end a circular aperture, chamber within conforming to the shape of the test; color gray.

Diameter at widest portion about 2 mm., length 18–20 mm.

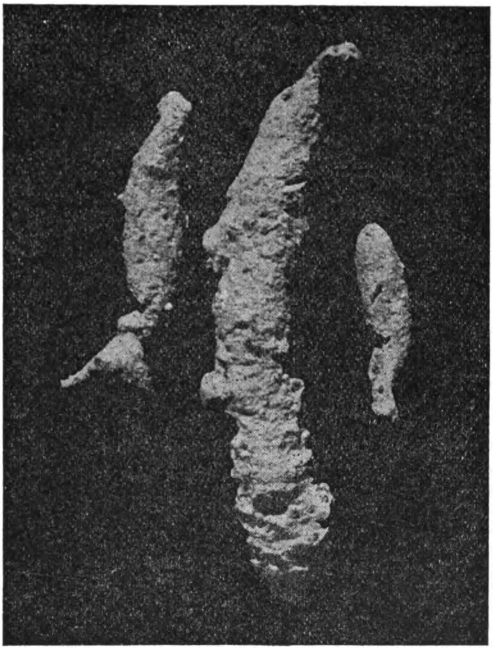


Fig. 52.—Pelosina variabilis. × 20 (after Flint).

*Distribution.*—In the North Pacific this species is known only from a single *Challenger* station, 246, in 2,050 fathoms, situated in the deep portion of the middle part of the North Pacific.

## Genus TECHNITELLA Norman, 1878.

*Technitella* Norman (type, *T. legumen* Norman), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 279.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 245.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 256.

*Description.*—Test free, usually elongate, subcylindrical, fusiform or elongate-oval, interior consisting of a single chamber; wall thin, composed of sponge spicules and fine sand, aperture rounded, single, at one end of the test.

Two species of *Technitella* are known from the North Pacific, and they both seem to be very rare. The genus is at once distinguished by the elongate arrangement of the sponge spicules in the direction of the long axis of the test.

### TECHNITELLA LEGUMEN Norman.

*Technitella legumen* NORMAN, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 279, pl. 16, figs. 3, 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 246, pl. 25, figs. 8-12.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 14, pl. 3, figs. 20-27.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 251, pl. 4, fig. 4.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 256, fig. 96 (in text).

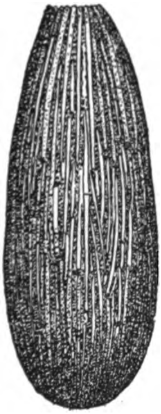


FIG. 53.—TECHNITELLA LEGUMEN. × 50.

*Description.*—Test subcylindrical, frequently somewhat curved, apertural end rounded or sometimes with a short tubular neck, aboral end rounded or sometimes bluntly pointed; wall composed of sponge spicules and sand grains, aperture rounded; color of test white or grayish white, sometimes with a coating of sand.

Length up to 2.5 mm.

*Distribution.*—Known from station 237 of the *Challenger* expedition, east of Japan, in 1,875 fathoms.

### TECHNITELLA MELO Norman.

*Technitella melo* NORMAN, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 280, pl. 16, figs. 5, 6.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 246, pl. 25, figs. 7 *a, b*.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 12.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 256, figs. 95 *a, b* (in text).

*Description.*—Test oval, being slightly tapering at the ends, aperture small, usually circular, at one end of the test; wall composed almost entirely of long sponge spicules arranged lengthwise of the test firmly united with a white cement; color white or grayish white.

Length, 1.4 mm.; diameter, 1.0 mm.

*Distribution.*—There is but the one North Pacific *Challenger* record for this species, station 237, east of Japan, in 1,875 fathoms.

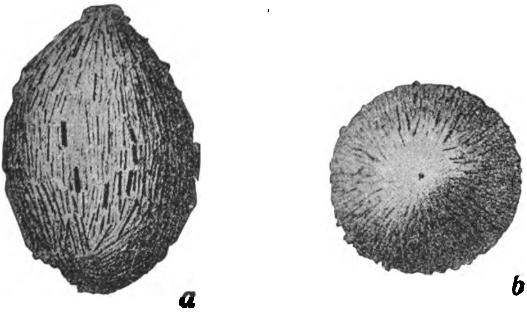


FIG. 54.—TECHNITELLA MELO. × 50 (AFTER BRADY). *a*, SIDE VIEW; *b*, APERTURAL VIEW.

### Genus THOLOSINA Rhumbler, 1895.

*Placopsilina* H. B. Brady (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 51; vol. 21, 1881, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 314.

*Tholosina* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82; Arch. Protistk., vol. 3, 1903, p. 226.

*Pseudoplacopsilina* Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 672.

*Description.*—Test attached, hemispherical, flattened on the side by which it is attached, chamber single, undivided; walls fairly thick, composed of sand grains with a large proportion of calcareous cement, walls roughened on the exterior.

The single species of this genus has been found but rarely in the North Pacific. It is easily distinguished when it is attached to dark colored tests like *Rhabdammina*, as its white color shows up strikingly against the darker background.

Rhumbler seems to be quite right in making a new genus for this species, which is quite different from the genus to which it has usually been assigned. The name proposed by Eimer and Fickert will have to go into the synonymy and the earlier name proposed by Rhumbler will stand.

#### THOLOSINA BULLA (H. B. Brady).

*Placopsilina bulla* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 315, pl. 35, figs. 16, 17.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 28, pl. 6, figs. 213–215 (not figs. 211, 212=*Ammolagena*); Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25.—Millett, Journ. Roy. Micr. Soc., 1899, p. 361, pl. 5, fig. 11.

*Tholosina bulla* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82.—Kiær, Norske Nordhavs-Exp., No. 25, 1899, p. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 227, fig. 52 (in text).

*Pseudoplacopsilina bulla* Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 672.

*Description.*—Test adherent hemispherical or strongly convex, flattened at the base to conform to the surface to which it is attached, usually slightly longer in one direction than the other; chamber single, usually undivided, walls thick, composed of sand grains with an excess of calcareous cement, surface uneven, apertures simple, nearly circular,

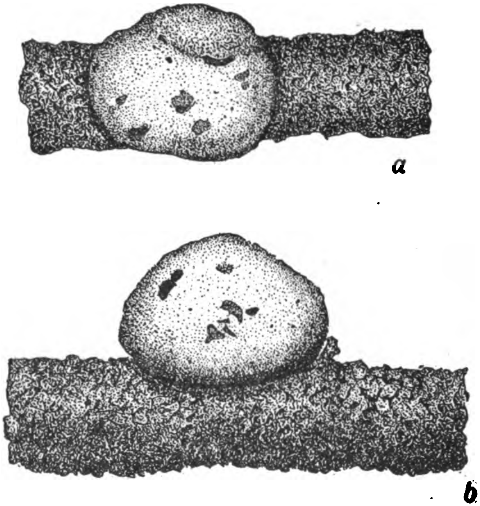


Fig. 55.—Tholosina bulla. × 15. *a*, from above; *b*, from side.

usually two in number, situated at either end near the base; color grayish white.

Diameter 0.5–1.0 mm.

*Distribution.*—The only published records for this species in the North Pacific are those of Goës, *Albatross* station D3399, in 1,740 fathoms off Panama and station D3419, in 772 fathoms off the west coast of Mexico. I have examined the material selected by Goës, consisting of five specimens attached to *Rhabdammina* and *Saccammina*. One of these specimens is figured here. This shows a slight tendency toward division as do certain other specimens. Goës[a] shows a longitudinal section of a specimen indicating a division into three chamberlets. Figures 211 and 212 referred to this species by Goës are really *Webbinella hemisphærica* (Jones, Parker, and H. B. Brady).

I have found a single specimen from Blake Reef, south of Japan, *Albatross* station H4881, 316 fathoms, which seems to be an immature specimen of this species. It is attached to a fragment of shell, slightly less convex than larger specimens, but otherwise similar. Another single specimen was found from *Albatross* station D5056, in 258 fathoms on the east coast of Japan, attached to a specimen of *Bathysiphon filiformis*. A third single specimen is from D4979 off Japan attached to a specimen of *Rhabdammina*.

### Genus WEBBINELLA Rhumbler, 1903.

*Webbina* JONES, PARKER, and H. B. BRADY, Pal. Soc. Monogr., 1865, p. 27 (not *Webbina* D'ORBIGNY, 1839).—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 348.—CHAPMAN, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 326.

*Psammosphæra* EIMER and FICKERT (part), Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.

*Webbinella* RHUMBLER (part), Arch. Protistk., vol. 3, 1903, p. 228.

*Description.*—Test adherent, circular in outline, the central portion convex, the peripheral portion often forming a flattened rim about the central portion; chamber single, undivided, wall of medium thickness, composed of sand grains with much cement, aperture not apparent, the pseudopodia being thrust out at the basal portion of the test near the line of its attachment.

The genus *Webbinella* as thus amended will exclude *Webbinella clavata* (Jones and Parker), which is placed in the genus *Ammolagena*, which seems very distinct. *Webbinella* as here understood contains the single species described below.

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[a] Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, pl. 6, fig. 215.

### WEBBINELLA HEMISPHÆRICA (Jones, Parker, and H. B. Brady).

*Webbina hemisphærica* JONES, PARKER, and H. B. BRADY, Pal. Soc. Monogr.. 1865, p. 27, pl. 4, fig. 5.—ROBERTSON, Rep. Brit. Ass., 1875, p. 189.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 350, pl. 41, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 266, pl. 14, figs. 1–3.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 24.

*Placopsilina bulla* GOËS (part), Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 28, pl. 6, figs. 211, 212 (not figs. 213–215).

*Psammosphæra hemisphærica* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 671.

*Webbinella hemisphærica* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 228, fig. 54 (in text).

*Description.*—Test adherent, circular in outline when seen from above, central portion convex, surrounded by a flattened border of varying width, chamber single, undivided, wall composed of sand grains with much cement, nearly smooth outside, more or less roughened within; aperture not visible, the region of attachment serving for the egress of the pseudopodia about its edge; color grayish-white or brownish.

Diameter 0.5–1.5 mm.

*Distribution.*—The two specimens which I have found in the *Albatross* material from the Northwest Pacific are the only records for this region. Single specimens attached to shell fragments were found, one at *Albatross* station D4874, in 66 fathoms in Korea Strait, near Japan, the other at D4900, in 139 fathoms in the Eastern Sea of Japan.

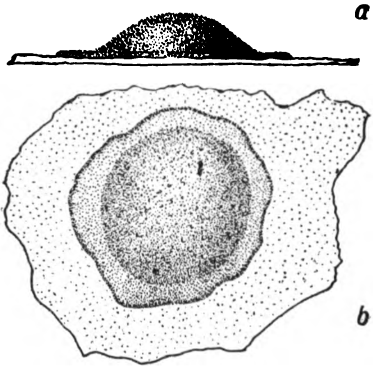


FIG. 56.—WEBBINELLA HEMISPHÆRICA, ATTACHED TO A FRAGMENT OF SHELL, × 50. *a*, FROM SIDE; *b*, FROM ABOVE.

## Genus AMMOSPHÆROIDES, new genus.

*Description.*—Test irregularly subglobular, composed of an elongate or subspherical chamber with double apertures typically; wall finely arenaceous with a large proportion of reddish-brown cement, apertures at the end of short tubular portions of the test.

*Type of the genus.*—*Ammosphæroides distoma,* new species.

The peculiar rusty appearance of the test and the double apertures at once separate this from any allied arenaceous forms.

### AMMOSPHÆROIDES DISTOMA, new species.

*Description.*—Test irregular, subglobular or with deep depressions of the surface, irregularly made up of two portions, each of which possesses an aperture; wall finely arenaceous, the outer portion flaking off when specimens are dried, fairly smooth, with an abundance of cement of a dark reddish-brown color; apertures at the end of very short tubular necks, irregular or nearly circular in section; color ferruginous, due to the dark reddish-brown color of the cement.

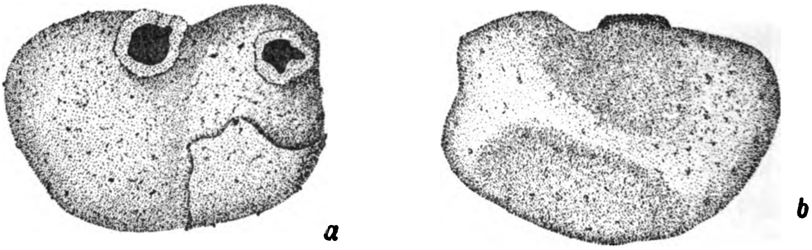


FIG. 57.—AMMOSPHÆROIDES DISTOMA. × 50. *a*, APERTURAL VIEW; *b*, FROM SIDE.

Diameter 0.4–0.8 mm.

*Distribution.*—Specimens of this species were fairly common at one *Albatross* station, D5018, in the sea of Okhotsk off the southern end of the eastern coast of Sakhalin Island, in 82 fathoms.

*Type-specimen.*—No. 8258, U.S.N.M., from the above station.

## Genus VERRUCINA Goës, 1896.

*Verrucina* Goës (type, *V. rudis* Goës), Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 232.

*Description.*—Test adherent, irregular-ovoid in shape; interior divided into irregular chamberlets, wall composed of sand grains, rough externally, aperture usually double, situated in the depressed area at the center of the dorsal side.

This genus of Goës contains a single species.

### VERRUCINA RUDIS Goës.

*Verrucina rudis* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25, pl. 1, figs. 15, 16.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 233, fig. 62 (in text).

*Description.*—Test adherent to *Rhabdammina*, the basal portion spreading over the surface of the tube, the other portion rising up into an irregular-ovoid shape, top flat, depressed in the center, cavity a single chamber divided irregularly into chamberlets, wall fairly thick, aperture single, but usually double at the bottom of the sunken area, color dark gray.

Length averaging about 2 mm.

*Distribution.*—Known only from the type station, *Albatross* station D3419, off the west coast of Mexico in 772 fathoms. I have examined the five specimens in the material selected by Goës as well as a few other specimens found in the original material from this station. Some of the specimens are much higher than is shown either in Goës's figure or in our figure. One specimen is somewhat higher even than the length of the base. With this exception the characters seem to be rather constant in the specimens examined.

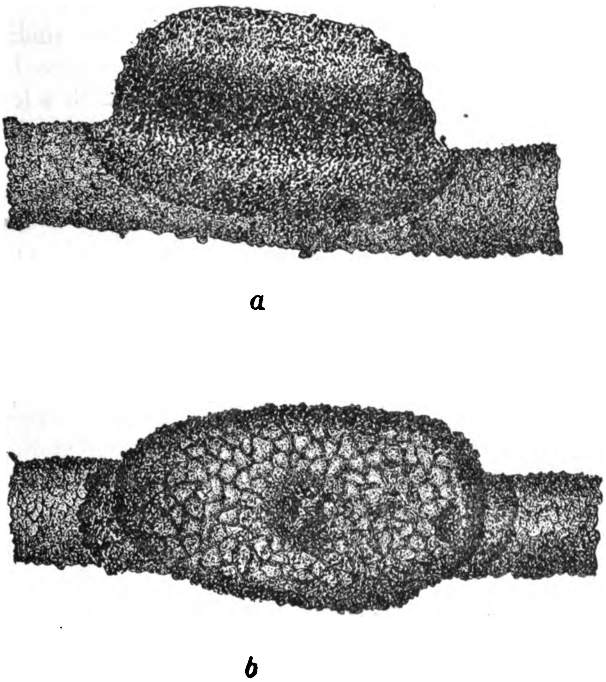


FIG. 58.—VERRUCINA RUDIS. × 10. *a*, SIDE VIEW; *b*, VIEWED FROM ABOVE.

## Genus CRITHIONINA Goës, 1894.

*Crithionina* GOËS (type, *C. mamilla* GOËS) Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 14; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 229.

*Description.*—Test spherical, lenticular, or variously shaped, interior either labyrinthic or with a single chamber, apertures small and scattered or indistinct, wall thick, composed of sponge spicules or very fine sand, often chalky in appearance.

This genus which has a considerable development in the Arctic and North Atlantic oceans seems to find similar conditions off the western coast of North America where several species occur. They seem in most cases to be specifically distinct from the Atlantic and Arctic forms. Four species occur off the west coast of America.

### CRITHIONINA RUGOSA Goës.

*Crithionina rugosa* GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24, pl. 2, figs. 3, 4.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 232, fig. 59 (in text).

*Crithionina abyssorum* (part) KIÆR, Norske Nordhavs-Exp., no. 25, 1899, p. 7, pl. 1, fig. 4 (not 1–3).

*Description.*—"Subglobular, with coarsely tuberculated surface; wall thick, obsoletely cavernous, the chamber somewhat irregular, showing faint traces of subdivision; color gray or whitish; the consistency of the shell is usually loose, the texture being finely arenaceous, with a large portion of shell débris. Diameter 1–2 mm."

*Distribution.*—Goës found and described this species from material from two *Albatross* stations D3415, in 1,879 fathoms off the west coast of Mexico and D3407, in 885 fathoms, near the Galapagos Islands.

The above description is copied from that of Goës. His specimens from the first of the two stations I have examined. There are six, rather poorly characterized specimens, more irregular than his figure. One of these specimens is figured here.

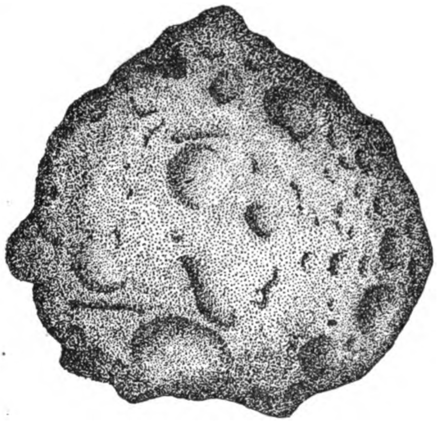


FIG. 59.—CRITHIONINA RUGOSA. × 20.

**CRITHIONINA LENS Goës.**

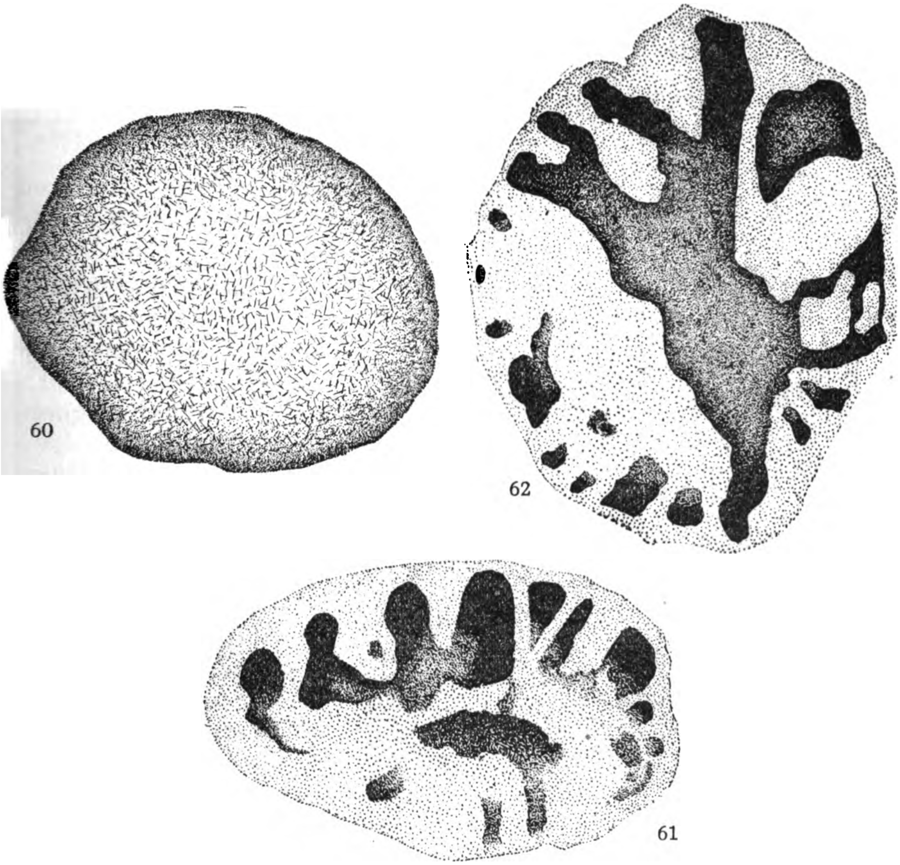
*Crithionina lens* GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24, pl. 2, figs. 5–8.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 232, fig. 60 (in text).

*Description.*—Test flattened, orbicular, elliptical or irregular in outline, thickest in the middle, giving a lens form to the test as a whole; interior with a central chamber and many large radial chamberlets irregular in number, size and shape, central cavity sometimes indistinct or obsolete; wall thick, composed of sponge spicules and fine amorphous matter with very fine sand; color light gray, often almost white.

Diameter 2–4 mm.

*Distribution.*—Goës records this species from three stations in the eastern tropical Pacific, one off Acapulco, Mexico, another south of Panama, the third near the Galapagos Islands, *Albatross* stations D3376, D3407, D3419, in 772–1,132 fathoms. This is the only region where this species has been met with. I have found a single poor specimen from station D4334, off San Diego, California.

A number of specimens selected by Goës have been examined, and I fail to find any such regularity in the divisions as shown by Goës's figures. In the accompanying figures are given two sections from Goës's material from station D3419.



FIGS. 60–62.—CRITHIONINA LENS. 60, SURFACE VIEW. × 15. 61, VERTICAL SECTION. × 20. 62, HORIZONTAL SECTION. × 20.

### CRITHIONINA PISUM Goës.

*Crithionina pisum* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 24, pl. 2, figs. 1, 2.—Millett, Journ. Roy. Micr. Soc., 1899, p. 250, pl. 4, fig. 3.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 266, pl. 6, fig. 1.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 242, fig. 57 (in text).

*Crithionina abyssorum* (part) Kiær, Norske Nordhavs-Exp., no. 25, 1899, p. 7, pl. 1, fig. 2 (not 1, 3, 4).

*Description.*—Test free, globular in typical form but variable, surface even, wall rather thick, soft, composed of loosely-matted sand

and sponge spicules, interior chamber single, undivided, apertures interstitial; color grayish white.

Diameter 1–3 mm.

The typical form of this species has not been recorded from the North Pacific, but it is represented by the following variety:

### CRITHIONINA PISUM Goës, var. HISPIDA Flint.

*Crithionina pisum* GOËS, var. *hispida* FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 267, pl. 6, fig. 2.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 230, fig. 61 (in text).—[?] BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 127.

*Crithionina abyssorum* (part) KIÆR, Norske Nordhavs-Exp., no. 25, 1899, p. 7, pl. 1, figs. 1, 3 (not 2, 4).

*Description.*—Variety differing from the typical in its smaller size and the hispid surface made up of a great number of sponge spicules arranged nearly perpendicular to the outer wall; walls somewhat thinner than in the typical.

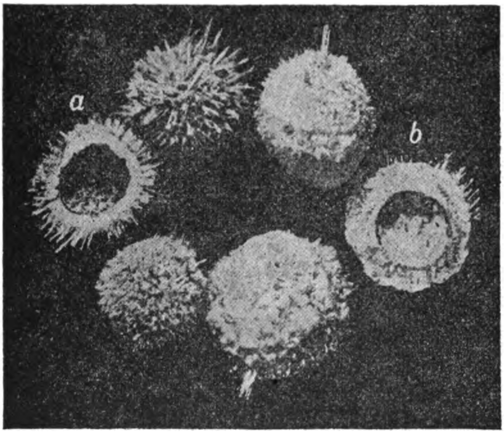


FIG. 63.—CRITHIONINA PISUM, VAR. HISPIDA. × 15 (AFTER FLINT). *a*, *b*, SECTIONS.

About one-half the size of the typical form.

*Distribution.*—One of the original stations for Flint's material was in the North Pacific, *Albatross* station D3080, in 93 fathoms, green mud, off Hecata Bank, Oregon. Bagg records the variety from two *Albatross* stations, H4440, in 1,259 fathoms, and H4502, in 1,342 fathoms, both stations in the vicinity of the Hawaiian Islands. I have failed to find this variety in any of the western Pacific material that I have examined.

The specimens from *Albatross* station H4502 in the National Museum labeled as this variety by Doctor Bagg seem to me to be very small spinose Radiolaria and not Foraminifera. The largest one measures but 0.05 mm. without the spines.

The figure given here is from the original of Doctor Flint.

### CRITHIONINA ROTUNDATA, new species.

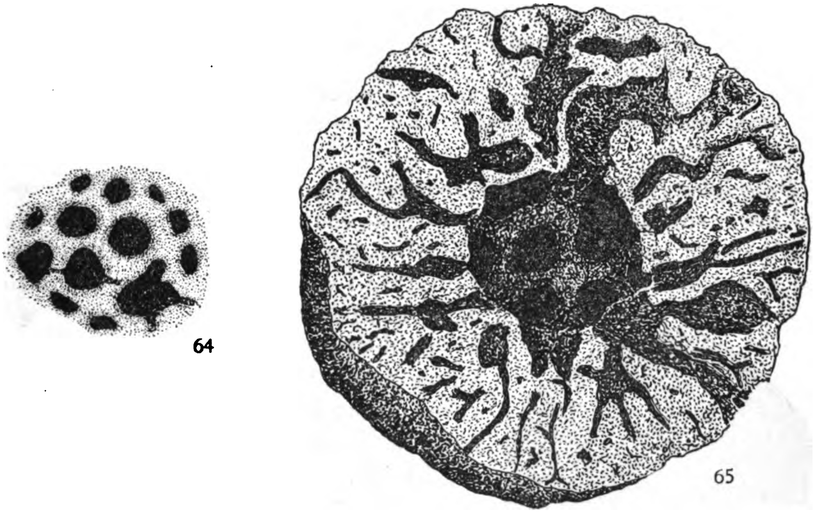
*Description.*—Test free, subspherical, composed of loosely agglutinated sand grains; surface with many pores leading by canals through the thick walls to the single central chamber, which is simple, nearly spherical, and small compared to the size of the test; wall of the chamber with many circular or roughly polygonal openings which ramify into the canals leading to the surface; wall of the central chamber and canals firmer than the rest of the test, usually showing in these firmer portions a reddish-brown cement; color dark grayish brown.

Diameter 3–6 mm.

*Distribution.*—Specimens of this species were common in the material from *Albatross* station D4327, off San Diego, Cal., 263–330 fathoms.

*Type-specimen.*—Cat. No. 8259, U.S.N.M.

This species is perhaps nearest to *Crithionina rugosa* and *C. mamilla* Goës. It is very much larger than either of those species and has a more definite structure. *C. mamilla* is an attached form of small size. *C. rugosa* is also a small, subspherical species. I have examined the original specimens of *C. rugosa* selected by Goës from the type station, and they are all small and largely made up of white, finely granular material of an entirely different appearance from this species. This is by far the largest species yet known in this genus.



FIGS. 64–65.—CRITHIONINA ROTUNDATA. 64, PORTION OF CENTRAL CHAMBER WALL. × 25. 65, VIEW OF SECTIONAL SPECIMEN SHOWING THICK WALL AND RADIAL TUBES. × 10.

### Genus THURAMMINA H. B. Brady, 1879.

*Thurammina* H. B. BRADY (type, *T. papillata* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 45.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 202.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 321.

*Thyrammina* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 236.

*Lituola* W. B. CARPENTER (part), The Microscope, 5th ed., 1875, p. 533.

*Description.*—Test typically free, usually nearly spherical, but in some species compressed, chamber single and undivided in typical species; wall thin, composed of fine sand with more or less chitin; apertures several to many at the end of nipple-like protuberances of the surface, occasionally wanting.

Two species occur rarely in the North Pacific; the third species, described by Goës, does not seem to be a Foraminifer as far as can be made out by a study of Goës's material.

### THURAMMINA PAPILLATA H. B. Brady.

"*Orbuline Lituola*" W. B. CARPENTER, The Microscope, 5th ed., 1875, p. 533, fig. 273 *g*, *h*.

*Thurammina papillata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 45, pl. 5, figs. 4-8.—W. B. CARPENTER, The Microscope, 6th ed., 1881, p. 561, fig. 320 *g*, *h*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 321, pl. 36, figs. 7-18.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 263, pl. 5, fig. 9.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 17.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 25.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 278, pl. 22, fig. 1.

*Thyrammina papillata* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 238, fig. 68*a–c* (in text).

*Description.*—Test usually free and rounded, occasionally adherent, the lower surface being adapted to the shape of the object to which it is adherent; usually a single chamber, but occasionally another chamber is found within the outer one; wall very thin, composed of small sand grains very neatly cemented with a reddish-brown cement, giving the whole test a reddish brown color; apertures numerous, variable, situated at the ends of nipple-like projections of varying length.

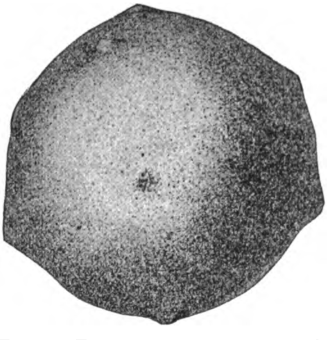


FIG. 66.—THURAMMINA PAPILLATA. × 30 (AFTER BRADY).

Diameter 0.4–1.6 mm.

*Distribution.*—All that is known of this species in the North Pacific is from the *Challenger* dredgings, stations 237, 246, 253, 269, in 1,875, 2,050, 3,125, and 2,550 fathoms, respectively. The first of these stations is a short distance east of Japan, the others in the deep water of the mid-Pacific. It also occurred at station 271, just south of the equator, in 2,425 fathoms.

From the figures and description there is evidently more than one thing now included under this specific name, but more material is necessary to be sure of this.

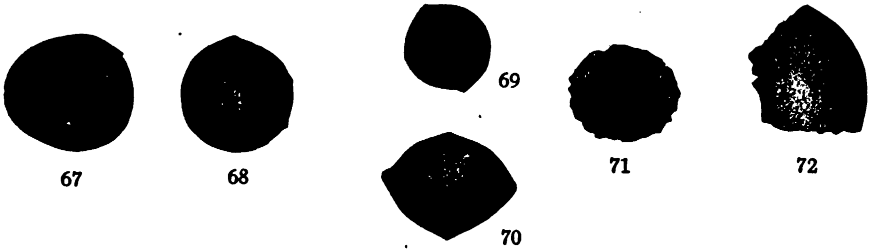
### THURAMMINA ALBICANS H. B. Brady.

*Thurammina albicans* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 46; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 323, pl. 37, figs. 2-7.

*Thyrammina albicans* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 237, fig. 67 (in text).

*Description.*—"Test spherical, or nearly so; with few, usually about six, mammillate orifices, equidistant and regularly disposed. Walls somewhat thicker than those of the type [*T. papillata*]; texture very finely arenaceous; color nearly white. Diameter about $\frac{1}{90}$th inch (0.28 mm.)."

*Distribution.*—Brady does not definitely record this species from the North Pacific in volume 9 of the *Challenger* Report, but in the second part of the volume on the "Summary of Results," this species is recorded on page 965, from station 246, 2,050 fathoms in the middle of the North Pacific.



FIGS. 67-72.—THURAMMINA ALBICANS. 67-70, SIDE VIEWS. × 50. 71, SECTION SHOWING THICKNESS OF WALL AND CHARACTER OF THE INTERIOR. × 50. 72, SECTION OF TEST SHOWING MINUTE STRUCTURE, × 100 (FIGS. AFTER BRADY).

The description and figures are from Brady.

### THURAMMINA ERINACEA Goës.

*Thurammina erinacea* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 26, pl. 2, figs. 9, 10.

*Thyrammina erinacea* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 237, fig. 66 *a*, *b*, (in text).

I have examined the material selected by Goës as belonging to this species and am inclined to think that they are Radiolaria and not Foraminifera at all. Radiolaria of this form and size are not uncommon on both sides of the Pacific. The mounted specimens are fastened to a strip of cardboard and are not easily examined, but some of the specimens are plainly Radiolaria.

Goës recorded this species from nine *Albatross* stations along the west coast of Mexico and Central America in 557-1,879 fathoms.

## Subfamily 3. HYPERAMMININÆ.

Test consisting of a globular proloculum and a more or less elongated, sometimes branching portion, but not divided into chambers; free or attached, wall of various agglutinated materials.

In this subfamily are included a number of genera with the above characters common to all. The main distinction between such genera as *Hyperammina*, *Botellina*, *Ammolagena*, etc., seems to be in the material of the test and the habit of growth rather than in essential differences in the general form of the test. All are of agglutinated material. In *Sagenina* the test is very much branched, sometimes anastomosing, but in essential features other than its excessive branching seems to belong with the others of this family.

## Genus HYPERAMMINA H. B. Brady, 1878.

*Rhabdopleura?* Dawson, Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86.

*Hyperammina* H. B. Brady (type, *H. elongata* H. B. Brady), (part), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 193.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 257.—Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82; Arch. Protistk., vol. 3, 1903, p. 257.

*Hyperammina*+*Bactrammina* Eimer and Fickert, Zeitschr. wiss. Zool., vol 65, 1899, pp. 673, 675.

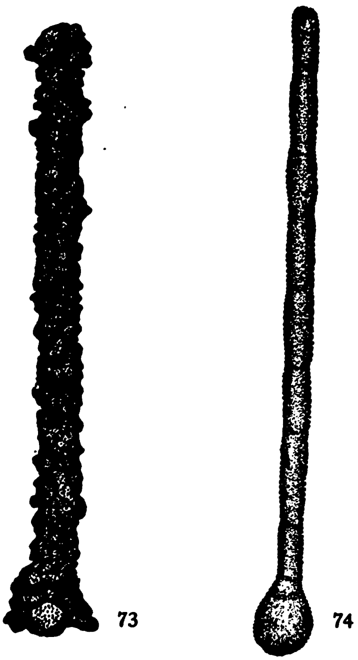
*Description.*—Test free, elongate, in general a simple cylindrical tube with a swollen proloculum at the proximal end, the distal end open and serving as the aperture, wall composed of sand grains, interior usually smoothly finished.

There are several species of *Hyperammina* in the North Pacific, but in general they are the species that are also known from other ocean basins. In general they are found in cool water and often at considerable depths.

### HYPERAMMINA ELONGATA H. B. Brady.

*Hyperammina elongata* H. B. Brady (part), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433, pl. 20, figs. 2 *a*, *b*; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 72; Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 98.—Balkwill and Wright, Proc. Roy. Irish Acad., vol. 3, 1882, p. 546.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 257, pl. 23, figs. 4, 7 (not 9, 10).—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 17, pl. 4, figs. 56–58 (not 55).—Chapman, Proc. Zool. Soc. London, 1895, p. 13.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 22.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 10, fig. 2 (part).—Kiær, Norske Nordhavs-Exp., no. 25, 1899. p. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 258, figs. 98 *a*, *b*, (in text).

*Bactrammina elongata* Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 673.



Figs. 73–74.—Hyperammina elongata. 73, test of comparatively large sand grains, from shallow water. × 15. 74, test of fine material from deeper water. × 12.

*Description.*—Test elongate, consisting of a long tubular portion of small diameter, composed of sand grains, proloculum broadly rounded, usually considerably larger than the diameter of the tube, wall usually consisting of but a single layer of sand grains with a varying amount of cement, smooth on the interior surface, rougher on the exterior; aperture at the distal end of the tube, little if at all constricted; color gray, sometimes brown, depending largely upon the color of the sand grains.

Diameter about 0.5 mm.; length up to 8 mm.

*Distribution.*—This species seems to be well distributed in the North Pacific. The *Challenger* records note it but twice in this region, in the abyssal region at 2,300 and 3,125 fathoms. Goës records it from two stations in the southeast portion of the region, *Albatross* stations D3375, 1,201 fathoms, and D3407, 885 fathoms.

I have records of its occurrence at about twenty *Albatross* and *Nero* stations in 110–2,848 fathoms. These stations are off California, near Hawaii, several near the Bonin Islands, five on the southeast coast of Japan, and two in Bering Sea.

Specimens of this species are usually without the proloculum, but a number of specimens in the present series show the complete test. It is of sand grains, coarse for the size of the tube as a rule, and the proximal end is broad and almost flattened in some cases. It is rather distinct from the following variety, although the two have been found in company with one another at one station.

### HYPERAMMINA ELONGATA H. B. Brady, var. LÆVIGATA J. Wright.

*Hyperammina elongata* H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884. p. 257, pl. 23, figs. 9, 10 (not 3, 7, 8).—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 17, pl. 4, fig. 55 (not 56–58).—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 10, fig. 2 (in part).—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 258 (in part).

*Hyperammina elongata* H. B. BRADY, var. *lævigata* J. WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 466, pl. 20, fig. 1.

*Description.*—Variety differing from the typical in its smooth test, great excess of cement, color yellowish or reddish brown, and the proloculum ovoid, somewhat fusiform in shape, but little larger in diameter than the tube but with somewhat of a constriction where it unites with the tube; usually of smaller size than the typical form.

*Distribution.*—Apparently more rare in the North Pacific than the typical, but not so everywhere. I have found specimens of this variety from *Nero* station 12, in 1,924

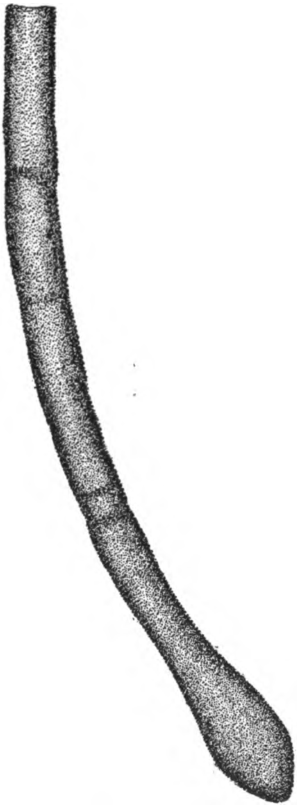


FIG. 75.—HYPERAMMINA ELONGATA, VAR. LÆVIGATA. SPECIMEN FROM *Albatross* STATION D4979, OFF JAPAN. × 40.

fathoms, near the Hawaiian Islands, station 1012, in 1,932 fathoms, north of Guam, and at *Albatross* stations D4970 and D4979, southeast of Japan, in 500 and 743 fathoms. At the last station it occurs with the typical form.

This variety seems to be rather distinct, and should be more definitely recorded, as it has certain characters of more than varietal rank, but it is kept here for the present.

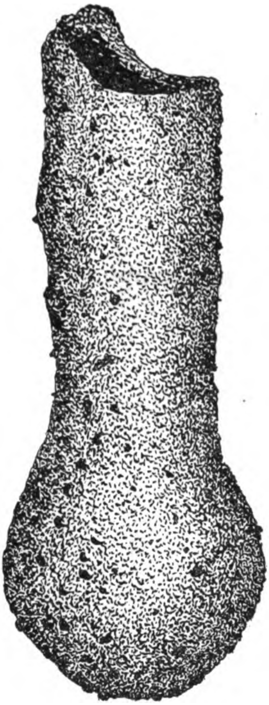


FIG. 76.—HYPERAMMINA FRIABILIS. SPECIMEN WITH THE UPPER PORTION OF THE TUBE BROKEN AWAY. × 50.

### HYPERAMMINA FRIABILIS H. B. Brady.

*Hyperammina elongata* H. B. BRADY (part), Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 32.

*Hyperammina friabilis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 258, pl. 23, figs. 1-3, 5, 6.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 17, pl. 4, fig. 59; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 269, pl. 10, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 258, fig. 99 *a*, *b*, in text.

*Description.*—Test elongate, subcylindrical, or tapering somewhat toward the distal end, nearly straight, test composed of coarse sand grains, wall thick and loosely cemented, exterior roughened, interior rather smooth, proximal end closed, forming a nearly spherical proloculum from which the elongated tubular portion originates, not always distinct from the exterior; aperture at the distal end small, nearly circular; color gray, often reddish-brown about the aperture and on the inner parts of the wall where there is more cement.

Diameter 2 mm., length up to 15–16 mm.

*Distribution.*—I have found specimens apparently of this species from four North Pacific stations: *Albatross* station D2806 in 1,329 fathoms near the Galapagos Islands, station D3608 from Holothurian stomachs; from Bering Sea, 279 fathoms; and at *Nero* station 1528, east of Guam, in 2,391 fathoms. A single specimen was found at *Albatross* station H4014, in 3,800 fathoms, the deepest record for this species. One specimen was found from *Albatross* station D4334, off California.

### HYPERAMMINA MAXIMA, new species.

*Description.*—Test elongate, straight or slightly curved, large, composed of a swollen proloculum and an elongate tubular chamber; wall thick, composed of sand grains and sponge spicules, rather loosely cemented, aperture rounded, formed by the open end of the tube; color gray or light brownish-gray.

Length up to 40 mm., diameter 2 mm.

*Type-specimen.*—Cat. No. 8211, U.S.N.M., from *Albatross* station D4337, off California.

This species is much larger than any of the others of the genus. Its walls have a large proportion of sponge spicules. At the type station this species occurred in great quantities with other arenaceous species.

FIGS. 77-79.—HYPERAMMINA MAXIMA. × 2. FROM PHOTOGRAPH.

### HYPERAMMINA SUBNODOSA H. B. Brady.

*Rhabdopleura*, species, G. M. DAWSON, Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86, fig. 7.

*Hyperammina subnodosa*, H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 259, pl. 23, figs. 11–14.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 255, pl. 4, fig. 32.—GOËS, Kongl. Svensk. Vet. Akad. Handl , vol. 25, No. 9, 1894, p. 16, pl. 3, figs. 42–53 (not 54).—SCHLUMBERGER, Mém. Soc. Zool. France, vol. 7, 1894, p. 254.—RHUMBLER, Arch. Protistk, vol. 3, 1903, p. 259, fig. 100 *a*, *b* (in text).

*Description.*—Test elongate, subcylindrical, comparatively large, proximal end enlarged into a thick-walled proloculum, tube constricted at intervals and with much thicker walls, coarsely arenaceous, aperture at the distal end of the tube, circular; color grayish.

Length up to 18 mm.

*Distribution.*—This species seems to be rare in the North Pacific. There are five records of its occurrence: *Challenger* stations 237, 241 east of Japan, in 1,875 and 2,300 fathoms; one station in the Okhotsk Sea, recorded by Schlumberger, in 280 meters; one *Albatross* station D5026, also in the Okhotsk Sea but a short distance from the preceding, 119 fathoms; and *Nero* station 1164, near the Bonin Islands, in 2,384 fathoms.

It may be worthy of note that at the shallowest station, *Albatross* station D5026, the bottom temperature in September was 30.4° F., even colder than at the abyssal stations where the species was found.

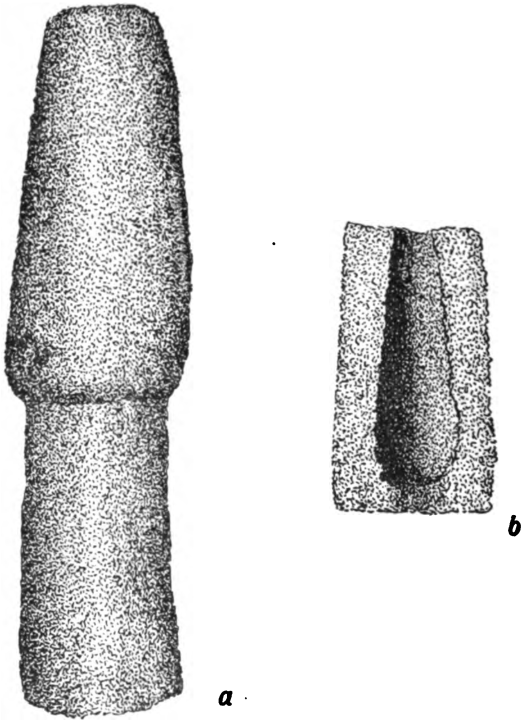


FIG. 80.—HYPERAMMINA SUBNODOSA, FROM THE OKHOTSK SEA × 10. *a*, SIDE VIEW; *b*, SECTION OF A PORTION OF THE CHAMBER LAID OPEN.

## Genus SACCORHIZA Eimer and Fickert, 1899.

*Hyperammina* H. B. BRADY (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 257.—RHUMBLER, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 82; Arch. Protistk., vol. 3, 1903, p. 257.

*Saccorhiza* (type, *Hyperammina ramosa* H. B. BRADY), EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 670.

*Description.*—Test free, consisting of an ovoid proloculum with a branching tube, composed of sand grains with many sponge spicules on the exterior, rough; open ends of the tubes serving as apertures.

This genus has been made for this species, which, in its branching, irregular habit and the almost invariable inclusion of sponge spicules, differs from the typical *Hyperammina*. The genus made by Eimer and Fickert has therefore been used. The other species of Rhumbler, with its inclusions of spicules, has also been included here, although known from but two fragmentary specimens.

### SACCORHIZA RAMOSA (H. B. Brady).

*Hyperammina ramosa* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33, pl. 3, figs. 14, 15; Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 98; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 261, pl. 23, figs. 15–19.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, no. 7, 1888, p. 217, pl. 41, figs. 1–4, 13.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 255, pl. 4, fig. 15.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 18, pl. 4, figs. 61, 62.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 13.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 22.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 11, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 260, figs. 101 *a*, *b* (in text).

*Saccorhiza ramosa* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 670.

*Description.*—Test free, proloculum ovoid passing into the branched tubular portion, branching irregular, wall fairly thick, composed of sand, more or less coated with sponge spicules exteriorly, rough; apertures at the ends of the tubes, color grayish.

*Distribution.*—This species seems to be generally distributed in the whole North Pacific, twenty-five or more well scattered stations having been noted. However, none of these records are north of latitude 40° N., but this is probably due to the fact that little material has been available in deep water north of that line.

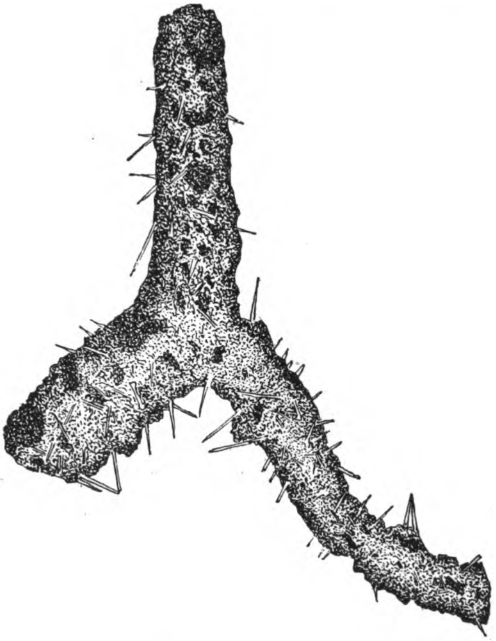


FIG. 81.—SACCORHIZA RAMOSA. × 100.

Complete specimens are very rare, but the fragmentary specimens, which are readily recognized, are common. This species is very different from the typical *Hyperammina* with the single tube and the ordinary sand grains. The investment of sponge spicules shows a selective character rather marked, for they are present on the test even from deep red-clay areas where spicules are not frequent in the same bottom sample in which the tests occur.

The figured specimen had very few spicules compared with the majority of specimens.

Specimens were obtained in the cold water off Japan in 39 fathoms, *Albatross* station D4946. The greater number of stations are over 1,000 fathoms, however, the deepest record of its occurrence being 3,125 fathoms.

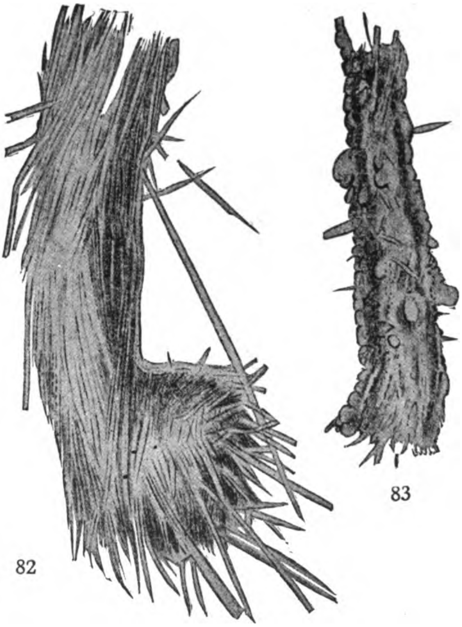
### SACCORHIZA CALCILEGA (Rhumbler).

*Hyperammina calcilega* Rhumbler, Zool. Jahrb. Abth. Syst., vol. 24, 1906, p. 24, pl. 2, figs. 1, 2.

*Description.*—Test free, consisting of a nearly spherical proloculum and a tubular portion, wall composed of calcareous sponge spicules and of other foreign calcareous granules; color white.

Length 0.6–0.9 mm., breadth 0.15–0.24 mm.

*Distribution.*—Two specimens from which Rhumbler described this species were found in shallow water at Laysan. Both are fragmentary specimens of small size, but their characters, especially the sponge spicules, would place the species in the genus *Saccorhiza*, as here considered. The calcareous nature of the foreign matter of the wall is not surprising when the almost universal calcareous nature of coral reef material is considered.



Figs. 82–83.—Saccorhiza calcilega. 82, specimen showing proloculum. × 115. 83, specimen showing apertural portion. × 60 (after Rhumbler).

### Genus TOLYPAMMINA Rhumbler, 1895.

*Hyperammina* H. B. Brady (part), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 260.

*Tolypammina* Rhumbler (type, *Hyperammina vagans* H. B. Brady), Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 83; Arch. Protistk., vol. 3, 1903, p. 276.

*Serpulella* Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 674.

*Description.*—Test typically adherent by its under surface, but may become free, consisting of an elongated oval proloculum and long irregular tube, unbranched, composed of sand grains and reddish-brown cement.

Rhumbler has proposed the above genus for the *Hyperammina vagans* of Brady. The attached habit and character of building the test seem sufficient grounds for its separation from others of the species usually assigned to *Hyperammina*. Eimer and Fickert also proposed a generic name for this species, but the name proposed by Rhumbler is several years earlier and is here used.

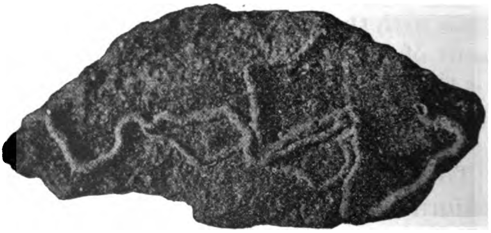


Fig. 84.—Tolypammina vagans. × 10. From photograph.

### TOLYPAMMINA VAGANS (H. B. Brady).

*Hyperammina vagans* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 33, pl. 3, fig. 5; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 260, pl. 24, figs. 1–9.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 270, pl. 11, fig. 2.

*Tolypammina vagans* RHUMBLER, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 83; Zeitschr. allg. Phys., vol. 2, 1902, p. 281, fig. 97; Arch. Protistk., vol. 3, 1903, p. 277, fig. 125 *a*, *b* (in text).

*Serpulella vagans* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 674.

*Description.*—Test typically adherent, consisting of an oval-elongate proloculum and a long irregularly winding tube of rather uniform diameter, unbranched, wall composed of sand grains of small size and united by a reddish-brown cement often in considerable amount, surface rather smooth, color reddish-brown, the proloculum often darker than the tubular portion.

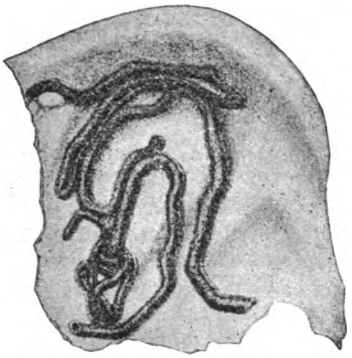


FIG. 85.—TOLYPAMMINA VAGANS. × 15 (AFTER BRADY). PROLOCULUM OF SPECIMEN SHOWN IN FIGURE JUST ABOVE THE MIDDLE.

Diameter 0.05–0.2 mm., length 1 mm. or more.

*Distribution.*—This species occurred at four *Challenger* stations and at eight stations in the *Albatross* and *Nero* material. These are well scattered in the region west of longitude 150° W. and south of latitude 40° N. Most of the stations are over 1,500 fathoms, but it has been noted in shallower water off Japan, *Albatross* stations D4949, in 110 fathoms, D4957in 437 fathoms. It occurred near the Hawaiian Islands, H2922 in 268 fathoms. The deepest record for this species in the North Pacific is at *Albatross* station H4014, 3,800 fathoms, attached to *Hyperammina friabilis.*

## Genus AMMOLAGENA Eimer and Fickert, 1899.

*Trochammina* JONES and PARKER (part), Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 142.

*Webbina* H. B. BRADY (part), Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711 (not *Webbina* D'ORBIGNY, 1839); Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 349.

*Ammolagena* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 673 (type, *Trochammina irregularis*, var. *clavata* PARKER and JONES).

*Webbinella* RHUMBLER (part), Arch. Protistk., vol. 3, 1903, p. 229.

*Description.*—Test adherent, composed of an oval proloculum with a tubular chamber of variable length but of nearly uniform diameter, the open end serving as the aperture; wall finely arenaceous but with an excess of cement, proloculum without a definite floor.

The generic name of this species following should be that proposed by Eimer and Fickert. *Webbina* as used by Brady is not at all the use as proposed by d'Orbigny. Eimer and Fickert proposed the name *Ammolagena* in 1899. Rhumbler includes with this species *Webbinella hemisphærica*, but as *Ammolagena* had already been proposed for it the name of *Ammolagena* Eimer and Fickert should stand and thus the generic name *Webbinella* is left for *Webbinella hemisphærica* in a restricted sense. The two species seem to be very distinct, *Ammolagena clavata* having a proloculum and long tubular chamber with the aperture at the end of the tube. *Webbinella hemisphærica* consists simply of a single adherent chamber with the aperture at the rim of attachment, and there is nothing corresponding to the long tubular portion seen in *Ammolagena clavata*.

The two species seem to be generically distinct and one seems related to the *Hyperammina* group and the other, *Webbinella*, to the single-chambered Saccammininæ.

### AMMOLAGENA CLAVATA (Parker and Jones).

*Trochammina irregularis*, var. *clavata* PARKER and JONES, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.

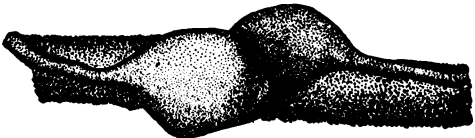
*Trochammina irregularis* (part), W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 142, pl. 11, fig. 6.

*Webbina clavata* H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 349, pl. 41, figs. 12–16.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, pt. 7, 1888, p. 218, pl. 42, fig. 21.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 470, pl. 20, figs. 2, 3.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 32, pl. 6, figs. 245, 246.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 18.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 35.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 24, fig. 3.—KIÆR, Norske Nordhavs-Exp. no. 25, 1899, p. 4.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 129.

*Ammolagena clavata* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 673.

*Webbinella clavata* RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 229, fig. 55 (in text).

*Description.*—Test adherent, consisting of an oval or pyriform proloculum of fairly large size, without a floor, arching upward, thin-walled, and a second tubular chamber of indefinite length, sometimes entirely attached; sometimes the later part free and circular in cross section; wall of fine sand grains, usually with an excess of reddish or yellowish brown cement, smooth; open end of the tube serving as the aperture.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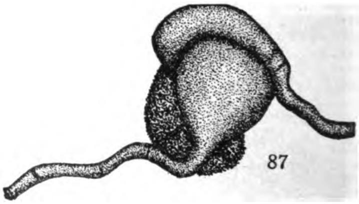
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FIGS. 86–87.—AMMOLAGENA CLAVATA. × 12. 86, TWO SPECIMENS ATTACHED TO THE SURFACE OF A SPECIMEN OF RHABDAMMINA. 87, TWO SPECIMENS ATTACHED TO A COILED ARENACEOUS TEST. ALL MEGALOSPHERIC SPECIMENS.

Longer diameter of the proloculum 0.5–1 mm.

*Distribution.*—The only *Challenger* record for this species is found in the volume on "Summary of Results." It is there recorded from station 237, 1,875 fathoms, east of Japan. Brady, in the ninth volume of "the *Challenger* Report," writes that it is a curious fact that he had not met with a single specimen in any of the North Pacific dredgings. In the Eastern North Pacific Goës has recorded this species from three stations off the coast of Mexico and Central America, 660–1,201 fathoms. Bagg records it from six stations in the vicinity of the Hawaiian Islands, 104–978 fathoms. In the present work I have found it from *Albatross* station D3431 where Goës records it, H2999, 549 fathoms, and *Nero* station 2032, 1,014 fathoms, both in the vicinity of the Hawaiian Islands.

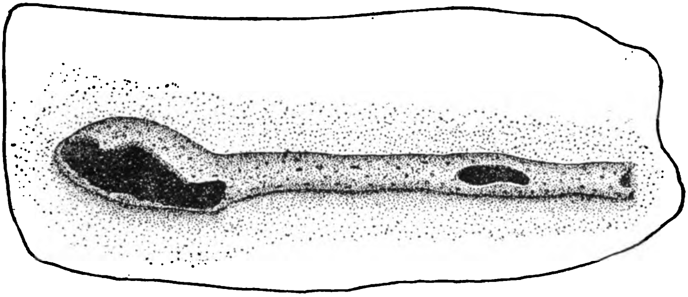


FIG. 88.—AMMOLAGENA CLAVATA. × 50. SPECIMEN ATTACHED, PORTION OF PROLOCULUM BROKEN AWAY. MICROSPHERIC SPECIMEN WITH SMALL PROLOCULUM AND COMPARATIVELY LONG TUBULAR PORTION.

I have examined Goës's selected material and also that selected by Bagg, now in the National Museum.

Besides being attached to pebbles, sand, grains, shells, etc., I have noted its occurrence on the following genera of Foraminifera: *Ammodiscus*, *Cyclammina*, *Rhabdammina*, *Haplophragmium*, *Biloculina*, *Pulvinulina*, and *Cristellaria*.

Wright, 1891, speaks of the difference in the length of tube being related to the size of the proloculum, the shorter tube with the larger proloculum, and the reverse. This would indicate a true dimorphism and would correspond to what is known in other groups, that the largest test is usually that with a microspheric proloculum.

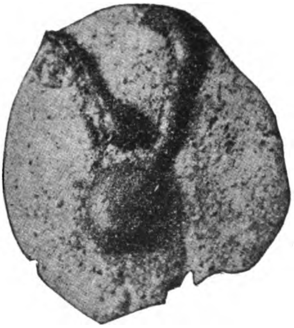


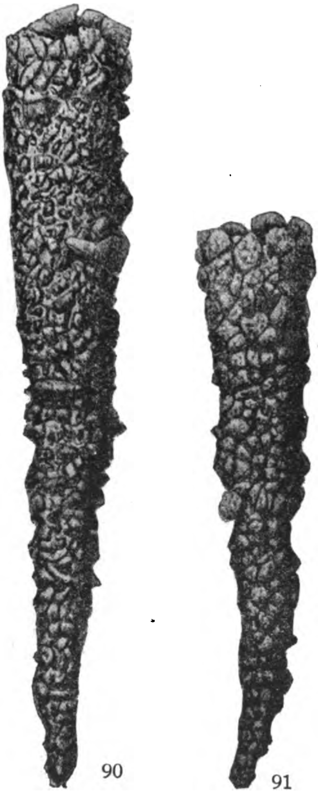
FIG. 89.—AMMOLAGENA CLAVATA. ×15. (FROM PHOTOGRAPH). MICROSPHERIC AND MEGALOSPHERIC SPECIMENS ATTACHED SIDE BY SIDE.

### Genus JACULELLA H. B. Brady, 1879.

*Jaculella* H. B. Brady (type, *J. acuta* H. B. Brady), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 35.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 193.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 255.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 273.

*Description.*—Test free, elongate, conical, widest at the apertural end, opposite end closed; wall thick, composed of sand grains roughly cemented on the exterior.

In *Jaculella* the distinction between proloculum and tubular chamber is not as marked as in some of the other genera, but in *J. obtusa* the relation is often made out more definitely. There are but two described species, both of which are recorded from the North Pacific, though but rarely.



Figs. 90-91.—Jaculella acuta. × 12 (after Brady).

### JACULELLA ACUTA H. B. Brady.

*Jaculella acuta* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 35, pl. 3, figs. 12, 13.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 19, no. 4, 1882, p. 143, pl. 12, fig. 432.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 255, pl. 22, figs. 14-18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 23.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 269, pl. 9, fig. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 273, fig. 122 (in text).

*Description.*—Test elongate, straight, tubular, proximal end closed and acutely pointed, distal end broader, slightly constricted to form the aperture which is circular, wall thick, composed of coarse sand grains, firmly cemented, exterior rough, proximal end of the test often reddish-brown, distal portion grayish.

Length variable, up to 25 mm. or even more.

*Distribution.*—Brady records this species at but one North Pacific *Challenger* station, 244, in 2,900 fathoms, in mid-Pacific. I have seen two specimens from *Albatross* station H2684 in 1,122 fathoms and H2917 in 2,615 fathoms, one off the coast of California, the other near the Hawaiian Islands.

The closed end of the specimens seems to be easily detached as they are rarely found complete.

### JACULELLA OBTUSA H. B. Brady.

*Jaculella obtusa* H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 714; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 256, pl. 22, figs. 19-22.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 20, pl. 4, figs. 87-89; pl. 5, figs. 90, 91; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 23.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 273, fig. 123 (in text).

*Description.*—Test elongate, straight, tubular, proximal end closed, obtusely rounded, distal end but slightly broader, its open end forming the aperture, wall thick, composed of sand grains, firmly cemented, rough, grayish in color.

Length 10–15 mm.

*Distribution.*—Known from a single *Challenger* station, No. 237, in 1,875 fathoms, east of Japan. Goës found specimens from *Albatross* station D3407, 885 fathoms, off the west coast of Mexico. I have found numerous other specimens from this latter station and have a few specimens from Bering Sea, *Albatross* station D3501, in 688 fathoms.

This species is often nearly cylindrical or wider in the middle than at either end, the texture rather less firm than is that of *J. acuta.*

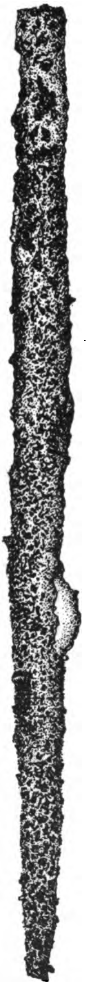


FIG. 92.—JACULELLA OBTUSA. × 15.

## Genus SAGENINA Chapman, 1900.

*Sagenella* H. B. BRADY (type, *S. frondescens* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 41; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 278 (not *Sagenella* HALL).

*Sagenina* CHAPMAN, Journ. Linn. Soc., vol. 28, 1900.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 221.

*Description.*—Test attached, tubular, dichotomously or irregularly branching, often anastomosing; wall arenaceous; apertures at the ends of the branches.

This genus contains several species, all occurring as far as known in the eastern seas and in tropical waters or in some cases subtropical as well.

### SAGENINA FRONDESCENS (H. B. Brady).

*Sagenella frondescens* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 41, pl. 5, fig. 1.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 195, pl. 5, fig. 16.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 278, pl. 28, figs. 14, 15.

*Sagenina frondescens* CHAPMAN, Journ. Linn. Soc., vol. 28, 1900, p. 4, pl. 1, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 221, fig. 46 (in text).

*Description.*—Test attached, tubular, stout, the tubes forming an irregular network over the surface to which they are attached, dichotomously branching or irregular and often anastomosing to form a reticulated network; wall of fine sand with a small proportion of cement, rather thin; apertures at the ends of the tubes, rounded; color white, gray, or brown.

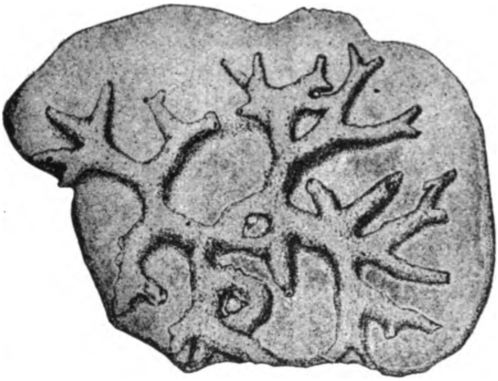


FIG. 93.—SAGENINA FRONDESCENS. × 10 (AFTER BRADY).

Diameter of the main tubes up to 0.5 mm., of the smaller ones as small as 0.12 mm.

*Distribution.*—Brady described this species from shallow water about the Admiralty and Friendly islands. A single fragmentary specimen was obtained from *Albatross* station D 4922 in Vincennes Strait, south of Japan, in 60 fathoms. At this and adjacent stations many other species of tropical Foraminifera seem to reach their northern limit.

### SAGENINA RAMULOSA, new species.

*Description.*—Test attached, tubular, branching profusely at a small angle, tubes often massed or confluent; wall composed of fine coralline mud, smooth; apertures at the ends of the tubes; color, white.

Diameter of the tubes, 0.1-0.2 mm.

*Type-specimen.*—Cat. No. 8232, U.S.N.M., from *Nero* station 1066, off Guam, 234 fathoms in coral mud, attached to fragments of worn shell.

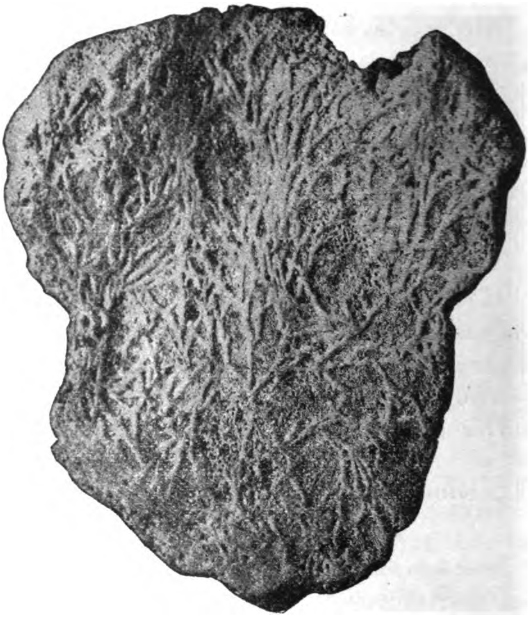


FIG. 94.—SAGENINA RAMULOSA. × 15. FROM PHOTOGRAPH.

This species is very slender, much more profusely branching than any specimens of the preceding species that I have seen, and most of the branching at a very acute angle.

### Subfamily 4. AMMODISCINÆ.

Test composed of a globular proloculum and long undivided tube, closely coiled, either planospirally or in changing planes or to form a spiral test; wall of fine sand with much cement.

*Ammodiscus* and its allies *Gordiammina, Ammodiscoides,* and *Turritellella* form a rather unified group in that they are all close coiled and are of fine material, with an abundance of reddish cement. As far as known the tests are all free. In *Ammodiscus* the two forms, microspheric and megalospheric, are known to occur.

### Genus AMMODISCUS Reuss, 1861.

*Operculina* (part) D'ORBIGNY, Foram. Cuba, 1839, p. 71.

*Orbis* STRICKLAND, Quart. Journ. Geol. Soc., vol. 2, 1846, p. 30 (not *Orbis* of PHILIPPI, 1844=*Cornuspira*).

*Spirillina* WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 93 (not *Spirillina* EHRENBERG, 1841).

*Trochammina* (part) JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141.

*Ammodiscus* (part) REUSS, Sitz. kais. Akad. Wiss. Wien, vol. 44 (1), 1861 (1862), p. 365.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 189.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 329.—RHUMBLER, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 614.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 280. (Type, *A. incertus* D'ORBIGNY =*Operculina incerta* D'ORBIGNY).

*Cornuspira* (part) REUSS, and various authors (not *Cornuspira* SCHULTZE, 1854).

*Involutina* (part) TERQUEM, Mém. Acad. Imp. Metz, 1860–61 (1862), p. 450; 1862–63 (1863), p. 221.

*Description.*—Test free, spiral, composed of a proloculum and long undivided tubular second chamber, coiled regularly in one plane, wall finely arenaceous, cement usually brown, surface smooth.

I have restricted *Ammodiscus* to the basis of Rhumbler, including only those species which have a truly planospiral test.

#### AMMODISCUS INCERTUS (d'Orbigny).

*Operculina incerta* D'ORBIGNY, in De la Sagra, Hist. Phis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 49, pl. 6, figs. 16, 17; Spanish Edit., 1840, p. 71, pl. 6, figs. 16, 17.

*Spirillina arenacea* WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 93, pl. 7, fig. 203.

*Trochammina squamata*, var. *incerta* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—PARKER and JONES, Appendix to W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 312.

*Trochammina incerta* W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 2.—HAEUSLER, Ann. Mag. Nat. Hist., ser. 5, vol. 10, 1882, p. 52, pl. 3.

*Ammodiscus incertus* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 330, pl. 38, figs. 1-3.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 484, pl. 11, fig. 7.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 552, pl. 8, fig. 8.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 326, pl. 6, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 263, pl. 5, figs. 35, 36.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 31, pl. 6, figs. 238, 239.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 17.—Ann. Mag. Nat. Hist., ser. 6, vol. 16, 1895, p. 315, pl. 11, figs. 8, 9.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 34.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 278, pl. 23, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 362.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 614, fig. 32 (in text).—RHUMBLER, Zeitschr. allg. Phys., vol. 2, 1902, p. 1, fig. 18; Arch. Protistk., vol. 3, 1903, p. 280, fig. 129 (in text).—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 5.

*Ammodiscus tenuis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 51; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 332, pl. 38, figs. 4–6.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 31, pl. 6, figs. 240, 241.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 18.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 23, fig. 1.—RHUMBLER, Arch. Protistk., vol. 3, 1903, p. 281, fig. 130 (in text).

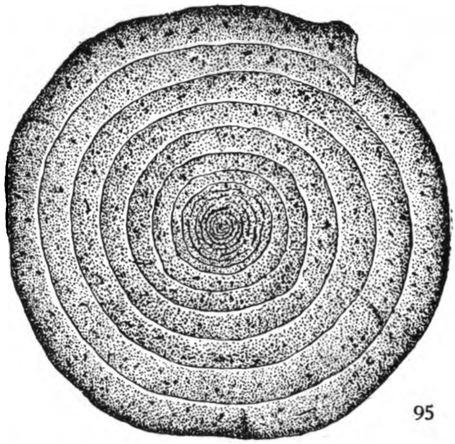
*Description.*—Test composed of an ovoid proloculum and long spirally coiled, undivided second chamber, coils in a single plane, gradually increasing in size, in the microspheric form very small in the center, in the megalospheric form much larger in the central portion and increasing but little in succeeding coils, in the adult condition chamber about as wide as high, building no floor of its own, aperture at the open end of the chamber, wall arenaceous, usually with an excess of cement, color usually a reddish or reddish-brown, in alcoholic specimens and sometimes in dry ones with the portion about the aperture white.

Diameter of test up to 6 mm.

*Distribution.*—Brady records a single station for this species in the North Pacific. Besides this station the volume on the "Summary of Results" of "The *Challenger* Report" adds another, 237, in 1,875 fathoms off Japan. Goës records the species as common off the west coast of Mexico and Central America from six *Albatross* stations. It is common in this material and from Station D3431, from which there are 129 specimens selected by Goës. Flint records it from Panama Bay in 51 fathoms.

Besides these records I have found the species in material from thirteen *Albatross* and *Nero* stations in the North Pacific. These are along the west coast of Mexico and the United States, at the entrance to the Gulf of California, off San Diego and off Oregon; two stations near the Hawaiian Islands; from along the south coast of Honshu Island, Japan, and near Guam. This gives a rather general distribution, but one station being north of lat. 40° N. The depths range from 20 to 3,125 fathoms, but only four stations are over 1,500 fathoms in depth. Of the shallower stations, two are 20 and 51 fathoms, the others between 250 and 1,150 fathoms, with the average of all less than 1,000 fathoms for this area.

There seems to be no great doubt that *Ammodiscus tenuis* H. B. Brady is the megalospheric form of the species of which *A. incertus* (d'Orbigny) is the microspheric form. From one station, *Albatross* D3431, there were 129 specimens, 26 of which were microspheric (*A. incertus*) and 103 megalospheric (*A. tenuis*); at station D3738, of 16 specimens, 2 were microspheric. At station D4337, 19 out of 30 specimens were microspheric. At several other stations both forms were obtained, but the amount of material did not admit of a large series being selected. In general, the megalospheric form is the more common, the usual feature wherever series of the two forms have been studied in other genera. Also the microspheric form is usually much larger than the megalospheric when the entire growth is finished. This also seems to be the general rule in the other Foraminifera observed from this standpoint.



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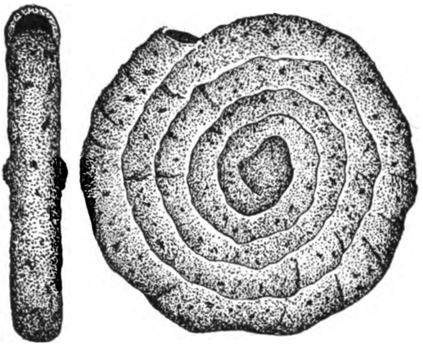

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FIGS. 95–96.—AMMODISCUS INCERTUS. × 20. 95, LARGE FORM WITH MICROSPHERIC PROLOCULUM AND MANY SMALL EARLY COILS. 96 *a*, FORM WITH MEGALOSPHERIC PROLOCULUM, MADE UP OF A FEW LARGE COILS, THE A. TENUIS H. B. BRADY WHICH IS THE MEGALOSPHERIC FORM OF A. INCERTUS (D'ORBIGNY); *b*, APERTURAL VIEW OF SAME SPECIMEN SHOWING THE MEGALOSPHERIC PROLOCULUM OF GREATER DIAMETER THAN THE SUCCEEDING PORTIONS OF THE TEST.

### AMMODISCUS EXSERTUS,
new species.

*Description.*—Test consisting of a proloculum and long undivided tubular chamber closely coiled for several revolutions, then uncoiling, but in the same plane, by a straight tube, wall finely arenaceous, with a reddish-brown cement, aperture at the end of the uncoiled portion, a circular opening slightly constricted.

Diameter 0.45 mm.

*Type-specimen.*—Cat. No. 8260, U.S.N.M., from *Albatross* D4979, in 943 fathoms, off the south coast of Honshu Island, Japan.

The specimen figured by Brady[a] has a similar form, but less developed.

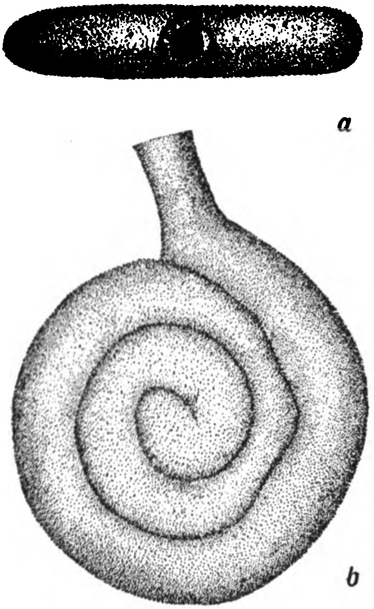

FIG. 97.—AMMODISCUS EXSERTUS. × 100. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

### Genus GORDIAMMINA Rhumbler, 1895.

*Trochammina* (part) Jones and Parker, Quart. Journ. Geol. Soc., vol. 61, 1860, p. 304.

*Ammodiscus* (part) Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 333.

*Gordiammina* Rhumbler, Nachr. kön. Ges. wiss. Göttingen, 1895, p. 84; Arch. Protistk., vol. 3, 1903, p. 281. Type, *G. charoides* (Jones and Parker) = *Trochammina charoides* Jones and Parker.

*Description.*—Test composed of a proloculum and long, undivided second chamber, winding upon itself in various planes, not completely spiral throughout, wall finely arenaceous, with much cement, smooth both without and within, color reddish or yellowish brown.

Rhumbler has proposed a new generic name to include the two species which have the coiled chamber winding in varying planes but not in a regular spire. The method of growth is certainly very different from the planospiral one of *Ammodiscus*, and the generic name used by Rhumbler has been adopted here.

### GORDIAMMINA GORDIALIS (Jones and Parker).

*Trochammina squamata*, var. *gordialis* Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—Parker and Jones, Trans. Roy. Soc. London, vol. 155, 1865, p. 408, pl. 15, fig. 32.

*Trochammina gordialis* W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 4.—Jones, Parker, and Kirkby, Ann. Mag. Nat. Hist., ser. 4, vol. 4, 1869, p. 390, pl. 13, figs 7, 8.—Wright, Proc. Belfast Field Club, 1876–77 (App.), pl. 4, fig. 3.—Haeusler, Ann. Mag. Nat Hist., ser. 5, vol. 10, 1882, p. 55, pls. 3 and 4, figs. 8–20.

*Trochammina* (*Ammodiscus*) *gordialis* Haeusler, Neues Jahrb., 1883, p. 59, pl. 4, figs. 2, 3.

*Ammodiscus gordialis* Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 196, pl. 5, fig. 22.—H. B. Brady, Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 100; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 333, pl. 38, figs. 7–9.—Haeusler, Neues Jahrb., Beil., vol. 4, 1885, p. 24, pl. 3, figs.

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[a] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, pl. 38, fig. 4.

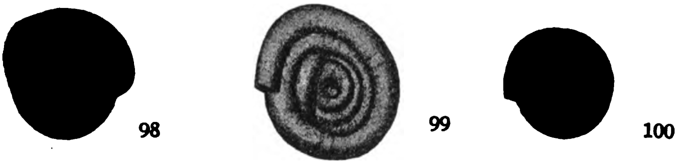
10–22, 31.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc. London, vol. 12, 1888, p. 218, pl. 42, fig. 22.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 469.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 264, pl. 5, figs. 39, 40.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 24., fig. 1.

*Gordiammina gordialis* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84; Arch. Protistk., vol. 3, 1903, p. 282, fig. 132 (in text).

*Description.*—Test composed of a proloculum and long, undivided second chamber, at first planospiral like *Ammodiscus*, but soon leaving the one plane and becoming irregularly; coiled wall finely arenaceous with much cement; color reddish or yellowish brown.

Diameter 0.25–0.84 mm.

*Distribution.*—There are seven *Challenger* records for this species in the North Pacific, six of them in the abyssal region from Japan westward to the mid-Pacific and thence southward to the equator, the other one between Hongkong and Manila. These stations range in depth from 1,875 to 3,125 fathoms, mostly in red clay areas. The only other North Pacific record is that of Flint, *Albatross* station D3080, in 93 fathoms off the coast of Oregon.



Figs. 98–100.—Gordiammina gordialis. × 70 (after Brady).

Many of the figured fossil specimens are very peculiar, and a question may be raised as to whether they all belong to this species.

### GORDIAMMINA CHAROIDES (Jones and Parker).

*Trochammina squamata*, var. *charoides* Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.

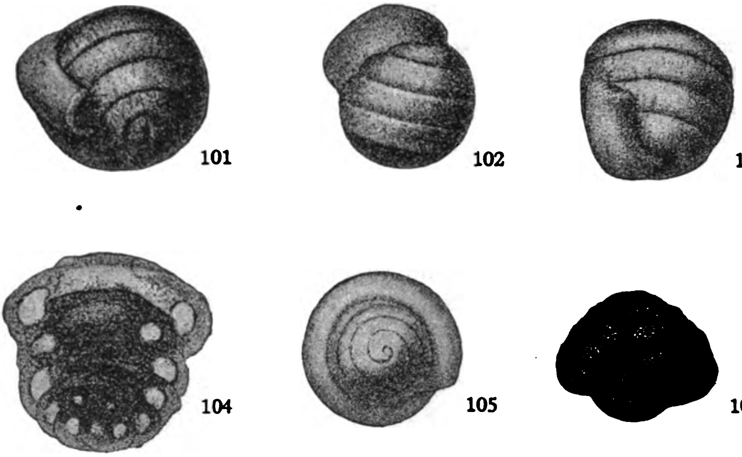
*Trochammina charoides* W. B. Carpenter, Jones, and Parker, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 3.—Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 5.—Haeusler, Ann. Mag. Nat. Hist., ser. 5, vol. 10, 1882, p. 56, pl. 4, fig. 21.

*Ammodiscus charoides* Berthelin, Foram. de Bourgneuf et Pornichet, 1878, p. 23, no. 18.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 334, pl. 38, figs. 10–16.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 469.—Chapman, Proc. Zool. Soc. London, 1895, p. 18.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 279, pl. 24, fig. 2.

*Gordiammina charoides* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.—Kiær, Norske Nordhavs-Exp., no. 25, 1899, p. 4.—Rhumbler, Arch. Protistk., vol. 3, 1903, p. 282, fig. 133 (in text).

*Description.*—Test consisting of a proloculum and long, undivided second chamber evenly coiled in a series of layers making a subglobular mass, then turning at right angles to its preceding axis and making finally a partial or complete revolution about the earlier-formed globular test; wall finely arenaceous with much cement; surface smooth and polished; color reddish brown.

Diameter 0.34–0.4 mm.



Figs. 101-106.—Gordiammina charoides. × 70 (after Brady). 104, section through test. 105, apertural view. 106, broken specimen showing coils of interior.

*Distribution.*—This species is known in the North Pacific from two *Challenger* stations in 1,875–2,575 fathoms, east from Japan. Brady also mentions a North Pacific station "from 50–150 fathoms." Flint records the species from off the coast of Oregon, 93 fathoms, from *Albatross* station D3080.

### Genus TURRITELLELLA Rhumbler, 1903.

*Trochammina* (part) Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 46.

*Ammodiscus* (part) Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5.—Balkwill and Millett, Journ. Micr. and Nat. Sci., vol. 3, 1884, p. 25.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 335.

*Turritellopsis* Rhumbler (not of G. O. Sars, 1878), Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.

*Turritellella* Rhumbler, Arch. Protistk., vol. 3, 1903, p. 283.

*Description.*—Test free, consisting of a proloculum and long, undivided second chamber, coiled in an elongated close spiral, wall composed of sand grains and much cement, smooth; aperture, the open end of the tubular chamber.

The single species here included has a long, closely spiral test very different from any of the preceding, and it seems proper that it should have a different generic name.

### TURRITELLELLA SHONEANA (Siddall).

*Trochammina shoneana* Siddall, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 46, figs. 1, 2.

*Ammodiscus shoneanus* Siddall and H. B. Brady, Cat. Brit. Rec. Foram., 1879, p. 5.—Balkwill and Wright, Proc. Roy. Irish Acad., vol. 3, 1882, p. 546; Journ. Micr. and Nat. Sci., vol. 3, 1884, p. 25, pl. 1, fig. 4.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 335, pl. 38, figs. 17–19.

*Turritellopsis shoneanus* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84; Zeitschr. allg. Phys., vol. 2, 1902, p. 284, fig. 103.

*Turritellella shoneana* Rhumbler, Arch. Protistk., vol. 3, 1903, p. 283, text fig. 135.

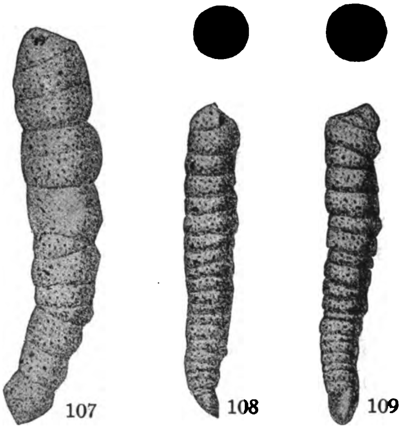
*Description.*—Test free, composed of a proloculum and long undivided tubular second chamber, in a close coiled, elongate spiral, of nearly uniform diameter, wall finely arenaceous, with much cement, rounded open end of the tubular chamber serving as the aperture, color reddish-brown.

Length 0.25–0.5 mm.

*Distribution.*—The only North Pacific record for this species is the deepest of the *Challenger* dredgings, station 238, 3,950 fathoms, east of Japan. In other parts of the world this species has been found in rather shallow water.

## Family 3. LITUOLIDÆ.

Test composed of agglutinated material for the most part; consisting of two or more chambers; arranged in a linear, coiled or irregular series; apertures usually one to each chamber, but sometimes more.



Figs. 107–109.—Turritellella shoneana. × 100 (after Brady).

The tests included in this family all have the wall composed of agglutinated material with a varying amount of cement in the various genera. Throughout the family as here used the tests are composed of two or more chambers and a definite proloculum is apparent. Usually the tests are composed of a series of chambers. There are well marked genera in the coiled group which in their later growth show a decided uncoiling and this may be carried to an extreme in such forms as *Ammobaculites agglutinans* where only the early portion shows any trace of coiling.

Several new genera have been made to include species which are very different in their plan of growth. The genera *Haplophragmium* and *Trochammina* especially have been divided. According to the type-species of *Haplophragmium* the test is uncoiled in later development, closely coiled when young, more or less labyrinthic in the interior and having several apertures. Such forms occur most commonly among the fossil series, but are also known as recent species in the East Indies. Therefore the genus *Haplophragmium* is here restricted to those species none of which have been recorded from the North Pacific.

The planospiral forms are here separated from the trochoid ones, as in the Mollusca, for example, these two types are always distinct, and it has seemed best to keep them so even in the Foraminifera. The uncoiling and closely coiled planospiral forms have also been separated. A number of previously proposed names have been used. Certain of the genera include species not hitherto described in this group, and which are apparently new.

After a careful review of the work done by various authors the scheme of distributing the genera of the Lituolidæ among the various families with which they are supposed to have affinities, has been avoided. It is less confusing, it seems to me, to keep the family as it now is, especially when the relationships of the arenaceous and calcareous forms are so hazy and uncertain and in other cases when details of structure are carefully considered the apparent likeness is lost. It has seemed best, therefore, to regard the similarity of form as cases of parallelism and not true relationships.

### Subfamily 1. ASCHEMONELLINÆ.

Test composed of agglutinated material, divided irregularly into chambers without definite plan of arrangement.

The two species of *Aschemonella* recorded from this area are primitive in character. The chamber seems to produce orifices at irregular positions and from any of these a new series of chambers may be initiated, thus giving rise to an irregularly formed test. In this respect these species seem more primitive than the rest of the family and are here separated from them.

### Genus ASCHEMONELLA H. B. Brady, 1879.

*Astrorhiza* (part) NORMAN, Proc. Roy. Soc. London, vol. 25, 1876, p. 213.

*Aschemonella* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 42.—BÜTSCHLI, in Bronns Klassen, und Ordnungen des Thierreichs, vol. 1, 1880, p. 195. Type, *Aschemonella catenata* (NORMAN)=*Astrorhiza catenata* NORMAN.

*Description.*—Test free, composed of a number of tubular or inflated chambers in a single or branching series, irregular in form and size, walls arenaceous, firm, thin, apertures often several, at the end of tubular necks.

The two following species were recorded from the material of the *Challenger* expedition as occurring in the North Pacific.

### ASCHEMONELLA RAMULIFORMIS H. B. Brady.

*Aschemonella ramuliformis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 273, pl. 27, figs. 12–15.

*Description.*—"Test free, elongate; forming an irregular, more or less branched, sometimes segmented tube, with numerous apertures, lateral and terminal. Walls very thin, but hard and firmly cemented; exterior only slightly rugose, interior surface smooth. Length, ⅓ inch (8 mm.)."

*Distribution.*—Found at three *Challenger* stations in the North Pacific, 244, 246, and 253, in 2,050–3,125 fathoms. Most common at station 244 in 2,900 fathoms.

### ASCHEMONELLA CATENATA (Norman.)

*Astrorhiza catenata* NORMAN, Proc. Roy. Soc. London, vol. 25, 1876, p. 213.

*Aschemonella catenata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 42, pl. 4, figs. 12, 13; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 271, pl. 27, figs. 1–11; pl. 27 A, figs. 1–3.

*Aschemonella scabra* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 44, pl. 3, figs. 6, 7.

*Description.*—"Test free, irregularly branched; chambers numerous, inflated, variable in size and contour, usually with several tubulated orifices, each of which may produce a fresh segment. Walls thin, compactly built, exterior more or less rough, often acerose with partially embedded sponge-spicules; interior smooth. Complete specimens sometimes $\frac{5}{12}$ inch (10.5 mm.) in length."

*Distribution.*—This species is recorded at four *Challenger* stations in the North Pacific, 224, 237, 244, 246, in 1,850–2,900 fathoms. Brady speaks of the specimens from station 244 as the finest obtained by the *Challenger*.

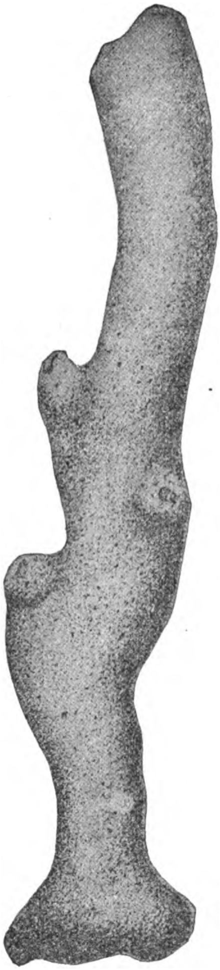
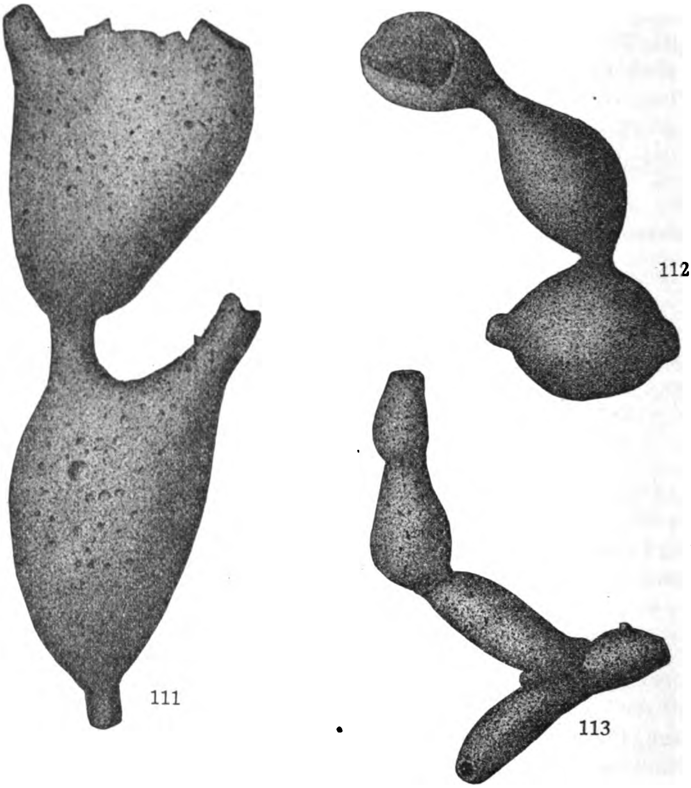


FIG. 110.—ASCHEMONELLA RAMULIFORMIS. × 15. (AFTER BRADY.)

## Subfamily 2. REOPHACINÆ.

Test of agglutinated material, sand grains, sponge-spicules, etc., with a varying amount of cement, chambers in a linear series, aperture single at the end of the last formed chamber.

This subfamily includes many species mainly belonging to *Reophax* and *Hormosina*. The chambers vary in relative length and in their relative position, sometimes closely fitting one over the other, sometimes drawn out with long tubular portions between the chambers. There is much difference in the materials used by various species, sand grains being the usual material, but certain species select sponge-spicules and in one species, *Reophax membranaceus* the test is composed largely of chitinous material.



FIGS. 111-113.—ASCHEMONELLA CATENATA. × 15 (AFTER BRADY).

## Genus REOPHAX Montfort, 1808.

*Reophax* MONTFORT (type, *R. scorpiurus* MONTFORT), Conch. Syst., vol. 1, 1808, p. 330, $83^{me}$ genre.—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 289.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 675.

*Nodosaria* D'ORBIGNY (not of LAMARCK, 1812) (part), Ann. Sci. Nat., vol. 7, 1826, p. 255.—TERQUEM, Mém. Acad. Imp. Metz, vol. 51, 1870, p. 354.

*Lituola* PARKER and JONES (part), Trans. Roy. Soc. London, vol. 155, 1865, p. 407.—PARKER, Can. Nat., vol. 5, 1870, pp. 177, 180.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 159.—SIDDALL, Proc. Chester Soc. Nat. Sci., pt. 2, 1878, p. 47.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 192.

*Haplostiche* SCHWAGER (not of REUSS, 1861), Jahresh. Ver. vat. Naturk. Württemburg, vol. 21, 1865, p. 92.

*Nodulina* RHUMBLER, Nachr. kōn. Ges. Wiss. Göttingen, 1895, p. 85.

*Description.*—Test free, composed of a linear series of chambers, joined end to end in a nearly straight line, sometimes slightly curved or irregular but not coiled, wall coarsely arenaceous, chambers undivided, aperture simple and terminal.

This genus as now modified includes the multiple chambered uniserial arenaceous forms with undivided chambers and a single oral aperture.

### REOPHAX SCORPIURUS Montfort.

"*Orthoceras*" ?, SOLDANI, Testaceographica, vol. 1, 1795, p. 239, pl. 162, fig. K.

*Reophax scorpiurus* MONTFORT, Conch. Syst., vol. 1, 1808, p. 330, 83$^{me}$ genre.—W. B. CARPENTER, The Microscope, 6th ed., 1881, p. 564, fig. 321*e*.—H. B. BRADY, Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 99.—HAEUSLER, Quart. Journ. Geol. Soc., vol. 39, 1883, p. 27, pl. 2, fig. 7.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 291, pl. 30, figs. 12–17.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 328, pl. 13, figs. 5 *a*, *b*.—HAEUSLER, Neues Jahrb. für Min., Beil., vol. 4, 1885, p. 9, pl. 1, figs. 9–16.—A. AGASSIZ, Bull. Mus. Comp. Zoöl., vol. 15, 1888, p. 163, fig. 495 (in text).—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 217, pl. 41, fig. 10.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 27, pl. 5, figs. 23, 24.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 467.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 320, pl. 5, figs. 4, 5.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 257, pl. 4, fig. 18; pl. 5, figs. 45, 46.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 24, pl. 5, figs. 158–163; pl. 6, figs. 164–167 [not 168–171].—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 14.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 26.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 273, pl. 16, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 254.—GUPPY, Proc. Victoria Inst., Trinidad, vol. 2, 1902, p. 3, pl. 2, fig. 2.—CHAPMAN, Trans. and Proc. New Zealand Inst., vol. 38, 1906, p. 84.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

*Nodosaria* (*Dentalina*) *scorpionus* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 255, No. 40.

*Lituola scorpiurus* H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 467, pl. 48, fig. 5.—Nat. Hist. Trans. Northumberland, vol. 1, 1867, p. 96, pl. 12, fig. 3.—DAWSON, Can. Nat., vol. 5, 1870, p. 177, fig. 4.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 159, pl. 9, fig. 29.—DAWSON, Amer. Jour. Sci., vol. 1, 1871, p. 206, fig. 4; Ann. Mag. Nat. Hist., ser. 4, vol. 7, 1871, p. 86, fig. 4.

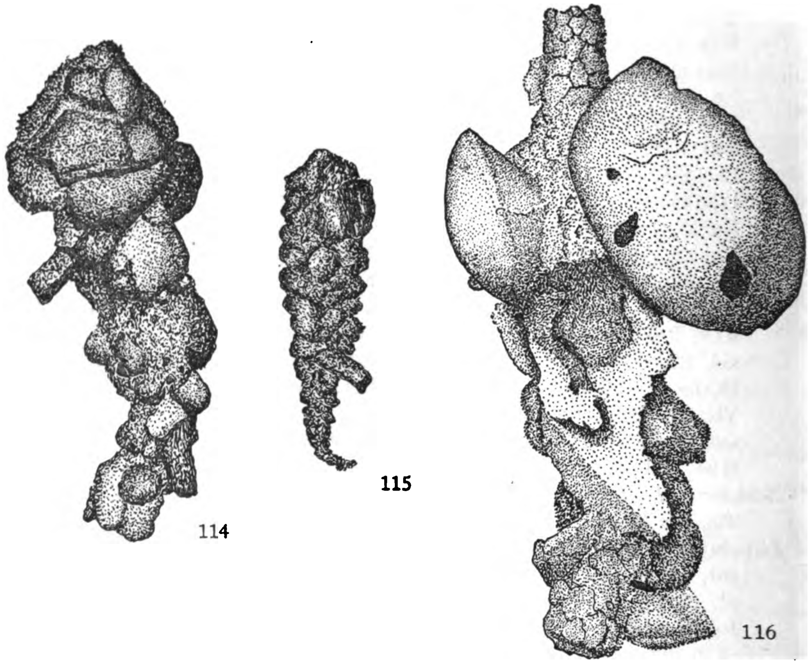
*Lituola nautiloidea*, var. *scorpiurus* PARKER and JONES, Trans. Roy. Soc. London, 1865, p. 407, pl. 15, fig. 48 *a*, *b*.—H. B. BRADY, Pal. Soc. Monogr., vol. 30, 1876, p. 63, pl. 8, fig. 7.—SCHWAGER, Boll. Reg. Com. Geol. Ital., vol. 8, 1877, p. 26, fig. 87.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 192, pl. 5, fig. 18.

*Description.*—Test consisting of a number of chambers, rapidly increasing in size as added, early chambers irregularly arcuate, later ones more nearly straight, surface rough, of fairly large sand grains, aperture simple, with a short neck, small.

Length 0.5–2 mm.

*Distribution.*—This species is recorded by Brady at seven *Challenger* stations from 40 fathoms on the coral reefs of Honolulu to 3,950 fathoms in the abyssal region east of Japan. Goës records it from *Albatross* station D3431, 995 fathoms at the entrance to the Gulf of California as scarce. Bagg records it from three stations near the Hawaiian Islands, 495–1,307 fathoms. I have found it in North Pacific material, from about Japan at a number of stations, and from the vicinity of Hawaii, usually in rather shallow water in both regions.

Of Bagg's specimens, only one, that from station D4567, can belong to this species. Of the other two specimens, one is not *Reophax*, the other very questionable. Some of the Goës material is typical, some of it rather nondescript.



Figs. 114–116.—Reophax scorpiurus, 114, specimen from Hawaiian Islands, 114 fathoms. × 20. 115, specimen from off Japan, 77 fathoms. × 15. 116, specimen of questionable character from Hawaiian Islands, 217 fathoms. × 10.

A review of the above synonymy will show that this specific name has been a sort of dumping ground for every irregular arenaceous Foraminifer or worm tube which is not definitely coiled or not well characterized. The original figure of Soldani on which Montfort based this species shows an arenaceous test with the early chambers irregularly arcuate, the later ones nearly straight and larger. Montfort made a fanciful copy of this figure of Soldani and the result is rather surprising, the figured specimens being made to show a network of raised ribs which were the lines between the sand grains in

Soldani's figure. With such a copy and the subsequent figures showing all sorts of arenaceous tests it is no wonder that there has existed great confusion in regard to this species.

The species is here restricted to those specimens showing the typical structure, such as Goës, 1894, pl. 5, fig. 158; pl. 6, figs. 164, 166, 167, and Flint, 1899, pl. 16, fig. 3.

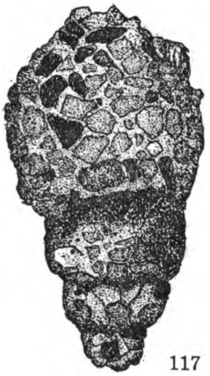
### REOPHAX PILULIFER H. B. Brady.

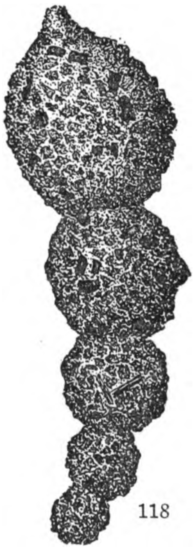
*Reophax pilulifera* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 292, pl. 30, figs. 18–20.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, pt. 7, 1888, p. 217, pl. 41, figs. 5–7 [8?].—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 273, pl. 18, fig. 1.

*Description.*—Test composed of few (three to five) chambers, arranged in a straight or slightly arcuate line, chambers subglobose, each much larger than the preceding, walls of coarse sand grains, but rather neatly cemented with considerable cement, giving a fairly smooth exterior, aperture small, often with a slight neck-like protuberance.

Length up to 2.5 mm.

*Distribution.*—In the *Challenger* material from the North Pacific this species occurs at stations 237 and 244, 1,875 and 2,900 fathoms, east of Japan. Goës found it in the *Albatross* material at station D3419, in 772 fathoms, in the eastern tropical Pacific, not 1,800 fathoms as he recorded it. His selected material consists of ten specimens from this station, a typical one of which is here figured. I have found two specimens from *Albatross* station D4957, in 437 fathoms, south of Japan. The figures given by Goës in 1894 are really *R. guttifer* H. B. Brady. Fig. 8, at least, of Brady, Parker, and Jones, 1888, is very questionable.





FIGS. 117–118.—REOPHAX PILULIFER. 117, SPECIMEN FROM SERIES SELECTED BY GOËS. × 20. 118, ANOTHER SPECIMEN. × 35.

### REOPHAX DISTANS H. B. Brady.

*Reophax distans* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 296, pl. 31, figs. 18–22.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.

*Description.*—Test composed of a few fusiform chambers with long slender connections in a straight line or irregular, usually not more than three chambers found together, wall of coarse sand grains, but rather smoothly cemented, thin.

Length of three chambered specimens, 5 mm.

*Distribution.*—The *Challenger* obtained this species from four North Pacific stations, 1,875–2,050 fathoms, between Japan and 180°. Goës records it from three *Albatross* stations off the west coast of Mexico and Central America, station D3419, 772 fathoms; D 3399, 1,740 fathoms; D3375, 1,201 fathoms. I have found single chambers in material from the stomachs of Holothurians taken at *Albatross* station D3603 in 1,771 fathoms, in Bering Sea; also single chambers at *Nero* station 1012, in 1,932 fathoms, north of Guam. The figured specimen is from *Albatross* station D3375.

Goës speaks of this material as "more globiform" than the specimens figured by Brady, but the material of Goës that I have examined seems very typical, consisting of ten single chambers and the one three-chambered specimen figured here. The slender connections between the chambers are very easily broken, and complete specimens are very rare.

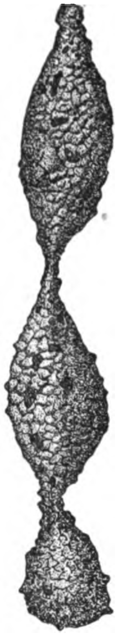


FIG. 119.—REOPHAX DISTANS. × 40.

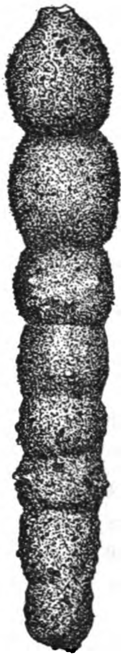


FIG. 120.—REOPHAX BACILLARIS. × 15.

### REOPHAX BACILLARIS H. B. Brady.

*Reophax bacillaris* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 49; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 293, pl. 30, figs. 23, 24.—DE AMICIS, Nat. Sic., vol. 14, 1895, p. 72, pl. 1, fig. 17.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 254, pl. 14, fig. 12.

*Description.*—Test elongate, regularly tapering, usually with an angle near the basal portion, composed of a large number (sometimes as many as thirty) of short chambers, earlier ones often less distinct than the later ones, aperture small, usually at the end of a very short neck-like protuberance; color gray.

Length up to 5 mm.

*Distribution.*—The only published records for the North Pacific are two stations from the eastern tropical Pacific recorded by Goës, *Albatross* stations D3375, D3376, 1,132 and 1,201 fathoms. I have examined his material from the latter station, two specimens, each with eight chambers, evidently not complete, but of the typical form. One of these specimens is figured (fig. 120).

### REOPHAX DENTALINIFORMIS H. B. Brady.

*Reophax dentaliniformis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 49; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884. p. 293, pl. 30, figs. 21, 22.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 25, pl. 6, figs. 172–175.—SCHLUMBERGER, Mém. Soc. Zool. France, vol. 7, 1894, p. 239.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 2.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 254.

*Reophax nodulosa* BAGG (not H. B. BRADY), Proc. U. S. Nat. Mus., vol. 34, 1908, p. 23.

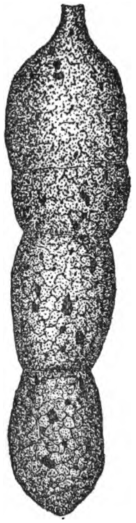


FIG. 121.—REOPHAX DENTALINIFORMIS. × 20.

*Description.*—Test slender, tapering, composed of a few (five or six) elongated chambers, but slightly tumid in the middle, in a straight or slightly curved line, walls composed of rather coarse sand grains but very neatly cemented together, giving a fairly smooth exterior, aperture rather large, at the end of the short tubular neck; color gray.

Length up to 2 mm.

*Distribution.*—This species is now known from fifteen stations in the North Pacific, down to 3,950 fathoms off Japan. Schlumberger records the species from the Okhotsk Sea and the other stations cover rather well the area south of lat. 40° N. from the coast of Japan to the Hawaiian Islands and off the west coast of Mexico and Central America.

Goës's specimens from Station D3276, 1,132 fathoms, are for the most part complete and typical. The specimen referred by Bagg to *Reophax nodulosus* is really a specimen of *R. dentaliniformis* H. B. Brady.

### REOPHAX NODULOSUS H. B. Brady.

*Reophax nodulosus* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 52, pl. 4, figs. 7, 8; Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 99; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 294, pl. 31, figs. 1–9.—TOUTKOWSKI, Zap. Kievsk. obshch. Est., vol. 9, 1888, p. 5, pl. 2, figs. 2 *a*, *b*.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 256, pl. 4, figs. 5–7, 12, 13 [?].—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 26, pl. 6, figs. 187–191.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 15.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 27.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 4.

*Description.*—Test elongate, tapering, usually straight but sometimes arcuate, consisting of several chambers (usually less than twelve) pyriform in shape, the proximal part of each chamber broadest, thence tapering gently toward the distal end, chambers gradually increasing in size toward the distal end of the test, exterior, in the large form with short chambers, roughish, in the form with long chambers, smooth; aperture large, at the end of the tapering chamber; color usually grayish.

Length very variable, up to 25 mm.

*Distribution.*—There are ten published records for this species which with the new stations from the *Albatross* and *Nero* soundings give a very general distribution for this species in the North Pacific, depths ranging from 941–3,950 fathoms.

Bagg's specimen from *Albatross* station H4585 assigned to this species is *Reophax dentaliniformis* H. B. Brady, as I find upon examination of his material. Goës's specimens, as well as all other North Pacific material that I have seen, are like plate 31, figs. 3 and 4 of the *Challenger* Report. Some of Goës's specimens had nine chambers. His specimens from the Caribbean Sea are more like figures 6–8 of the same plate, and it is very probable that Brady has included more than one species under this name. Egger's figures seem to represent a mixed assemblage of little character, none of which appears to be a typical *Reophax nodulosus.*

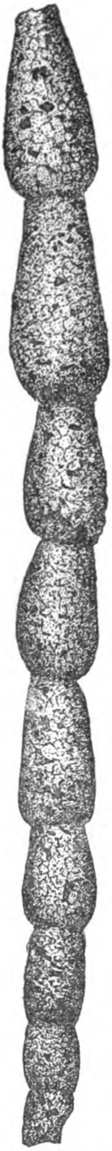


FIG. 122.—REOPHAX NODULOSUS. × 25.

### REOPHAX GUTTIFER H. B. Brady.

*Reophax guttifera* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 49; Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 295, pl. 31, figs. 10–15.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 26, pl. 6, figs. 192–195.

*Reophax pilulifer* GOËS (not H. B. BRADY), Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 25, pl. 6, figs. 176–180.

*Description.*—Test elongate, nearly straight, composed of from 3–8 chambers, typically pyriform, broadest at the base and rather rapidly narrowing to the aperture at the distal end of the chamber, wall composed of coarse sand grains, rather roughly cemented; color yellowish-brown.

Length up to 1.6 mm.

*Distribution.*—With the exception of the Philippines the only records for the North Pacific for this species are from the *Challenger* material, stations 237 and 246, 1,875 and 2,050 fathoms, east of Japan.

The narrow stolon-like connections between the chambers make the test very fragile and probably account for the fact that specimens with slender connections are composed of few chambers. Goës's figures are very small and it is difficult to determine exactly what he had. Goës's figures of *R. pilulifer* are apparently *R. guttifer*, as near as one can make out.

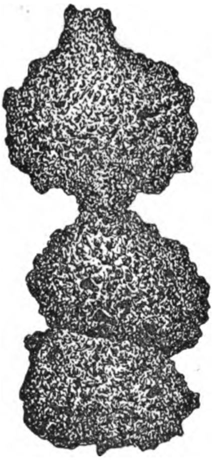


FIG. 123.—REOPHAX GUTTIFER. × 100.

### REOPHAX INSECTUS Goës.

*Reophax insectus* GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 28, pl. 3, figs. 6, 7.

*Description.*—Test stout, tapering, consisting of several short, inflated chambers, each larger than the preceding one, wall composed of large sand grains and rather rough on the exterior; circular in end view; light gray in color.

Length 5–8 mm., the last chamber often 2 mm. in diameter.

*Distribution.*—Goës described this species from material from *Albatross* stations off the west coast of Mexico and near the Galapagos Islands, *Albatross* stations D3407, D3419, and D3431, in 772–995 fathoms. Besides seeing the original material and finding additional specimens at the last station, I have found two specimens from *Albatross* station D4337, in 617–680 fathoms off San Diego, California. The material from this station was very similar to that from farther south, and might equally well be termed "Rhabdammina ooze."

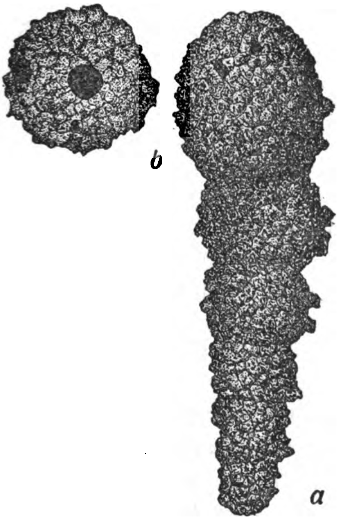


FIG. 124.—REOPHAX INSECTUS. × 12. *a*, SIDE VIEW; *b*, END VIEW.

### REOPHAX ADUNCUS H. B. Brady.

*Reophax adunca* H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 296, pl. 31, figs. 23–26.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 5.

*Description.*—Test consisting of several subglobular chambers in an irregular line, constrictions between the chambers slight, walls thin, composed of rather coarse sand grains giving a rough exterior, length indefinite, 2 mm. or more.

*Distribution.*—The only North Pacific records for this species are from *Challenger* stations 237, 244, 246, and 256, 1,875–2,950 fathoms, all curiously enough between lat. 30° and 40° N.

This differs from the other species of *Reophax*, and when its early development is known, may be placed elsewhere. It has the appearance of the later chambers of certain attached species which later become free or coiled species, straightening out in their later development. Flint's figures show specimens of identical character with those obtained by the *Challenger*.

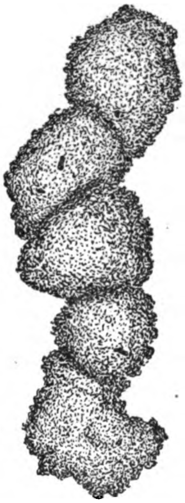


FIG. 125.—REOPHAX ADUNCUS. × 50.

### REOPHAX MEMBRANACEUS H. B. Brady.

*Reophax membranacea* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 53, pl. 4, fig. 9; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 297, pl. 32, figs. 1–4.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 255, pl. 4, fig. 14.

*Description.*—Test elongate, slender, tapering, straight or slightly curved, consisting of from five to ten subcylindrical, elongated chambers, slightly tumid in the middle; walls thin, chitinous, of a brown color; length up to 1.4 mm.

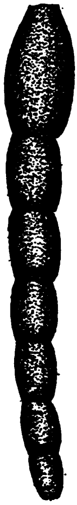


FIG. 126.—REOPHAX MEMBRANACEUS. × 200.

*Distribution.*—Brady records this species from *Challenger* station 238 in 3,950 fathoms off Japan and in the volume on the "Summary of Results" it is questionably recorded from the next station, 237, in 1,875 fathoms. I have found specimens in material from three *Nero* stations, 1012, 1021, 1030, in 1,932–2,112 fathoms, north of Guam. Specimens were very rare.

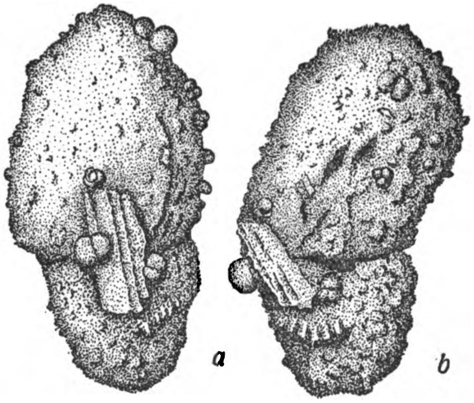


FIG. 127.—REOPHAX BILOCULARIS. × 25, *a*, FRONT VIEW; *b*, SIDE VIEW SHOWING THE OBLIQUITY OF THE CHAMBERS.

These specimens, one of which is figured here, are more like the specimens figured by Brady than those figured by Millett. The walls are very thin and clean.

### REOPHAX BILOCULARIS Flint.

*Reophax bilocularis* FLINT, Rep. U.S. Nat. Mus., 1897 (1899), p. 273, pl. 17, fig. 2.

*Description.*—Test composed of two chambers in a straight line or set at an angle, chambers oval, walls of foreign matter, sand and largely of tests of other Foraminifera, surface irregular, aperture at the end of a tubular neck.

Length up to 2.5 mm.

*Distribution.*—I have found a single specimen from *Nero* station 1464, in 891 fathoms in globigerina ooze. This station is just north of Guam. The specimen appears to belong to this species. It has two chambers of an oval shape, set at a slight angle. The wall made up of a small part of sand with tests of other Foraminifera and other foreign material making up the rest.

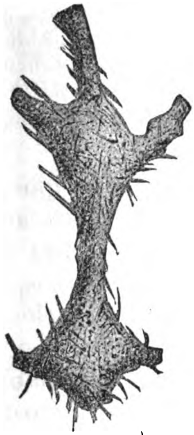
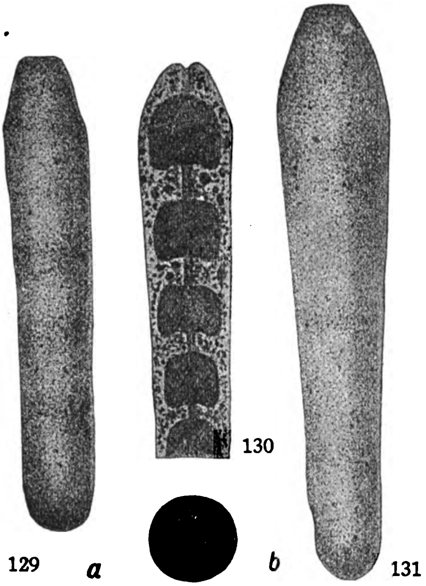


Fig. 128.—Reophax armatus. × 22 (after Goës).



Figs. 129–131.—Reophax cylindricus. × 20 (after Brady). 129 *a*, side view; *b*, apertural view. 130, longitudinal section. 131, side view.

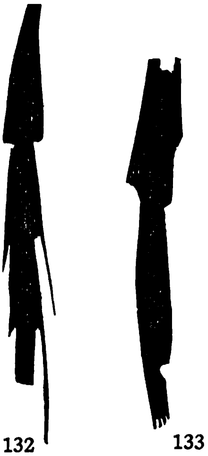
### REOPHAX ARMATUS Goës.

*Reophax armatus* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 29, pl. 1, fig. 1.

There are no specimens of this peculiar form in the material returned to the National Museum by Goës. From his figure and description it is difficult to determine just what was the character of Goës's specimens. The Pacific specimen was from *Albatross* station D3415 in 1,879 fathoms, off the coast of Mexico.

### REOPHAX CYLINDRICUS H. B. Brady.

*Reophax cylindrica* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 299, pl. 32, figs. 7-9.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 257, pl. 4, fig. 37 [?].—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 274, pl. 18, fig. 6.



Figs. 132–133.—Reophax spiculifer. × 50 (after Brady).

This species is recorded in the volume of the *Challenger* report on the "Summary of Results," from station 237, 1,875 fathoms, east of Japan. The record is followed by a question mark, as though there were some doubt about the correctness of the determination.

### REOPHAX SPICULIFER H. B. Brady.

*Reophax spiculifera* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 54, pl. 4, figs. 10, 11; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 295, pl. 31, figs. 16, 17.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 258, pl. 4, fig. 19 (?).—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 14.

*Description.*—Test composed of a few chambers, broadest at the posterior end of each and gradually narrowing to the apertural end; wall composed of elongate sponge spicules arranged in general lengthwise of the chamber, often projecting back toward the posterior end of the chamber; aperture circular.

Length about 1 mm.

*Distribution.*—In the volume of the *Challenger* report on the "Summary of Results" this species is recorded with a question mark from stations 237 and 246, 1,875 and 2,050 fathoms. I have not met with it in the material I have examined from the North Pacific.

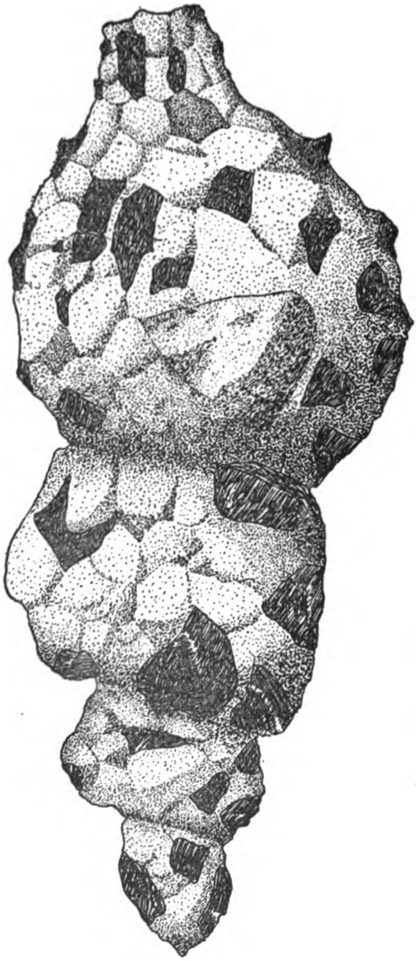


FIG. 134.—REOPHAX EXCENTRICUS. × 80.

### REOPHAX EXCENTRICUS, new species.

*Description.*—Test small, composed of a nearly straight linear series of chambers, the size rapidly increasing with each newly added chamber; wall composed of sand grains, rather neatly cemented together; aperture at the end of a short tubular neck at one side of the axis of the test, varying somewhat in the amount of its eccentricity; color gray.

Length, 1.5 mm.; diameter of last-formed chamber often 0.6 mm.

*Type-specimen.*—Cat. No. 8261, U.S.N.M., from *Albatross* station D3603, from the stomachs of Holothurians dredged in 1,771 fathoms in Bering Sea.

### REOPHAX CATENULATUS, new species.

*Description.*—Test consisting of a series of subglobular chambers of large size connected by rather slender tubular portions, walls of coarse sand grains very roughly cemented, color gray or yellowish-brown.

Length of three chambers, 7 mm.; diammeter of largest chamber, 1.8 mm.

*Type-specimen.*—Cat. No. 8262, U.S.N.M., from *Albatross* station D4965 in 191 fathoms, off the southern coast of Japan.

This is one of the largest species of the genus and the exterior is very rough.

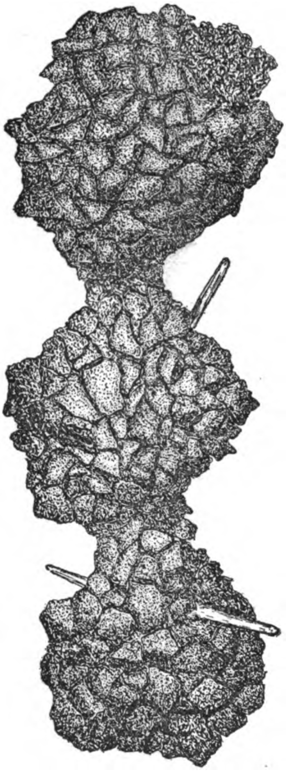


FIG. 135.—REOPHAX CATENULATUS. × 25.

## Genus HORMOSINA H. B. Brady, 1879.

*Hormosina* H. B. BRADY (type, *H. globulifera* H. B. BRADY), Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 199.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 325.

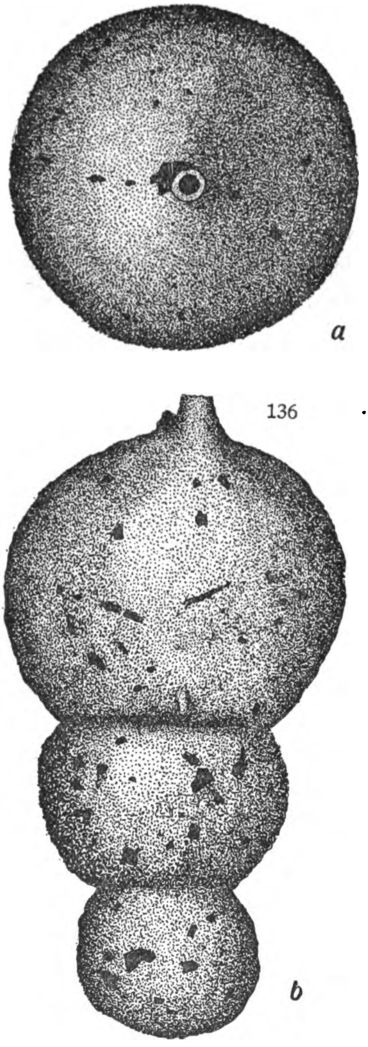
*Description.*—Test free, composed of a series of subglobular, fusiform or pyriform chambers joined end to end in a single moniliform series, walls thin, finely arenaceous, chambers undivided, aperture a single circular opening at the distal end of the neck of the chamber, color brownish.

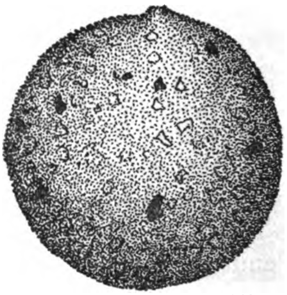
This genus differs from *Reophax* mainly in its fine texture, smooth surface, and brown cement. Several species occur in the North Pacific, but usually in fairly deep water.

### HORMOSINA GLOBULIFERA H. B. Brady.

*Hormosina globulifera* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 60, pl. 4, figs. 4, 5.—W. B. CARPENTER, The Microscope, 6th ed., 1881, p. 563, fig. 320*c* (in text).—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 326, pl. 39, figs. 1–6.—DE FOLIN, Le Naturaliste, vol. 10, 1888, p. 87, figs, 1, 2.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 29, pl. 6, figs. 218, 219.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 17.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 34.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 280, pl. 24, fig. 4.

*Description.*—Test composed typically of a few subglobular chambers, each larger than its predecessors and more or less embracing it, arranged in a straight or slightly arcuate line, aperture small, at the end of a definite, tubular neck, walls finely arenaceous, thin, surface smooth both within and without; color, light brownish.

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FIGS. 136–137.—HORMOSINA GLOBULIFERA. 136*a*, END VIEW SHOWING APERTURE; *b*, FRONT VIEW, × 35. 137, SINGLE CHAMBERED FORM, × 40.

Length about 3 mm.

*Distribution.*—In the *Challenger* material this species occurred at four North Pacific stations, 237, 241, 244, 246, in 1,875–2,900 fathoms, all on the eastward voyage from Japan to the mid-Pacific. Goës records the species from four *Albatross* stations in the eastern tropical Pacific, D3375, D3376, D3407, D3415, in 888–1,879 fathoms. The figured specimen is from the Goës material from Station D3415.

Goës speaks of the specimens as not quite typical, but his specimens agree very well with Brady's figures and description.

### HORMOSINA OVICULA H. B. Brady.

*Hormosina ovicula* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 61, pl. 4, fig. 6.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 199, pl. 5, fig. 15.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 327, pl. 39, figs. 7–9.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 29, pl. 6, figs. 220, 221.—Chapman, Proc. Zoöl. Soc. London, 1895, p. 17.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 280, pl. 25, fig. 2.

*Hormosina ovicula*, var. Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 34, pl. 4, fig. 3.

*Description.*—Test composed of several fusiform chambers joined end to end with slender connective portions, in a straight or slightly curved line, wall thin, finely arenaceous, color yellowish-brown with a distinctly darker reddish-brown portion at the distal end of the neck of each chamber.

Length up to 4 mm.

*Distribution.*—There are four *Challenger* records for this species, station 206, in 2,100 fathoms, west of Luzon, stations 237, 238, 246, in 1,875–3,950 fathoms, on the line east from Japan. Goës records the species from two *Albatross* stations off the west coast of Mexico and Central America, D3357 in 789 fathoms and D3415 in 1,879 fathoms, the specimens being small and scarce.

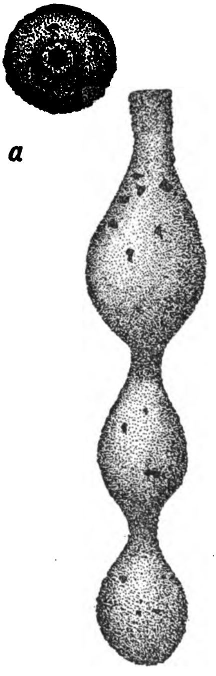

Fig. 138.—Hormosina ovicula. × 45. *a*, end view showing aperture; *b*, side view.

Goës speaks of the material as not typical, but while the specimens from the Caribbean Sea are not typical that from the Pacific is much more so. The figured specimen is from *Albatross* station D3915 and is very typical, even to the color bands of the neck of each chamber.

### HORMOSINA NORMANII H. B. Brady.

*Hormosina normanii* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 52; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 329, pl. 39, figs. 19–23.

*Description.*—Test composed of a few subspherical segments, earlier ones small, later ones much larger, irregularly arranged, aperture at the end of a tubular neck often near the entrance of the last previous aperture or at one side, walls very thin, smooth both without and within.

Length, 8 mm.

*Distribution.*—In the *Challenger* material this species occurs at three stations, 241, 244, 246, at 2,300, 2,900, and 2,050 fathoms, respectively, all in the one line of soundings east from Japan.

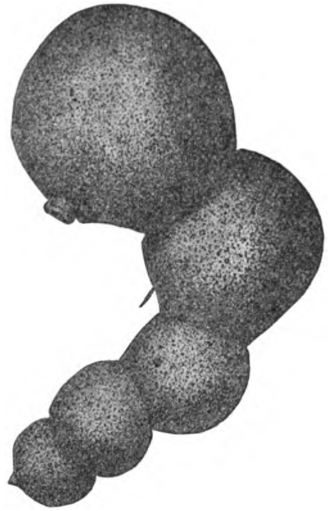

FIG. 139.—HORMOSINA NORMANII. × 10. (AFTER BRADY.)

### Genus HAPLOSTICHE Reuss, 1861.

*Nodosaria* (part) D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 252.—REUSS, Vers. böhm. Kreide, vol. 1, 1845–1846, p. 26, pl. 13, figs. 12–13.

*Lituola* (part) JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 307.

*Haplostiche* REUSS, Sitzb. kön. böhm. Ges. Wiss., Jahrg. 1861, p. 16.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 317. Type, *H. fœdissima* REUSS, 1865.[a]

*Description.*—Test free, cylindrical, composed of a linear series of chambers, variously divided into labyrinthic cavities; walls thick, coarsely arenaceous but usually fairly smooth on the exterior; aperture in the middle of the terminal face, in the early chambers simple, in the adult made up of several pores or dendritic.

There seems to be but a single recent species occurring in shallow or medium depths usually in tropical or subtropical waters.

#### HAPLOSTICHE DUBIA (d'Orbigny).

"*Orthoceratia Zoophytica minuscula*" SOLDANI, Testaceographica, vol. 1, pt. 2, 1791, p. 93, pl. 98, fig. A.

*Nodosaria dubia* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 252, No. 10.

*Lituola dubia* PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 8, 1871, p. 263, pl. 9, fig. 30.

*Lituola soldanii* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 307, no. 184.

*Haplostiche soldanii* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 318, pl. 32, figs. 12–18.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 263, pl. 4, figs. 34, 35.—FLINT, Rep. U. S. Nat. Mus. 1897 (1899), p. 277, pl. 21, fig. 3.

*Description.*—Test free, cylindrical or fusiform, made up of a linear series of rather short chambers, usually straight; wall composed of coarse sand grains neatly cemented, thick, produced in the chamber and causing a labyrinthic condition; aperture in the early chambers a single opening, simple, in adults becoming cruciform, dendritic or in some cases the divisions are separated, giving several openings; color variable, usually light gray.

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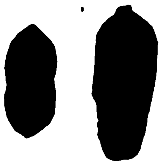
[a] No type-species was designated by Reuss, but as his model was based upon *Dentalina fœdissima* Reuss 1861, that may best be taken as type.

Length up to 7.5 mm.; diameter up to 2 mm.

*Distribution.*—The only published record for this species in the North Pacific is that of Bagg, who recorded it from two *Albatross* stations in the vicinity of the Hawaiian Islands, D4000 in 104–213 fathoms and H4590 in 978 fathoms. I have found specimens in material from *Nero* station 2071 in 271 fathoms, also near the Hawaiian Islands and at *Albatross* station D. 4900 in 139 fathoms off Japan.



FIGS. 140-141.—HAPLOSTICHE DUBIA × 7. FROM PHOTOGRAPH.

The dendritic aperture is supposed to distinguish this species from any others that may be confused with it, but in the smaller specimens which have not attained adult characters the aperture is simple. The labyrinthic condition of the interior is also characteristic. As d'Orbigny's name is the first to be referred to the figure of Soldani, priority will make necessary the use of his name *dubia* instead of *soldanii* Jones and Parker.

### Subfamily 3. TROCHAMMININÆ.

Test composed of several chambers, either in a planospiral coil, trochoid, or otherwise arranged, wall composed of sand grains of varying degrees of coarseness cemented with a calcareous or ferruginous cement, free or attached.

This subfamily as here used contains the many-chambered arenaceous forms not arranged in a linear series throughout. Except the large, somewhat anomalous form, *Neusina agassizii*, for which a separate subfamily has been made. Some of the species, such as *Ammobaculites tenuimargo*, appear to be largely made up of a linear series, but have a close coiled early portion not seen in the Reophacinæ.

### TROCHAMMINOIDES, new genus.

*Description.*—Test free, typically planospiral, composed of several coils, each constricted into a number of chamber-like portions with the openings between large; wall of fine sand and a yellowish-brown cement; aperture simple at the end of the last-formed chamber.

*Type of the genus.*—*Trochammina proteus* Karrer.

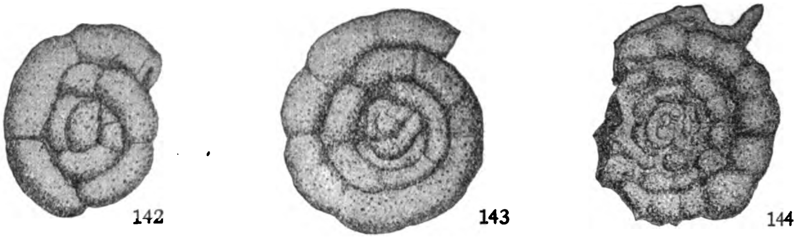
This species frequently shows a tendency to continue the *Ammodiscus* condition through one or more of the early coils, and the latter portion only may be divided, or in other specimens the divisions may occur much earlier. By its early development the genus is seen to have been derived from an *Ammodiscus* condition, as its early development consists of a proloculum and long coiled chamber as in *Ammodiscus*, but its later constricted condition foreshadows the condition of complete division seen in the chambered coiled forms usually assigned to *Haplophragmium* and *Trochammina*.

### TROCHAMMINOIDES PROTEUS (Karrer).

*Trochammina proteus* Karrer, Sitzb. kais. Akad. Wiss. Wien, vol. 52 (Abth. 1), 1865 (1866), p. 494, pl., fig. 8 (not 1–7).—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 341, pl. 40, figs. 1–3.—Haeusler, Neues Jahrb., Beil., vol. 4, 1885, p. 28, pl. 3, fig. 24 (25–27?).—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 266, pl. 5, figs. 7, 8 [?].—Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 694, fig. 42 (in text).—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 25, fig. 3.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 128.

*Ammodiscus proteus* Rhumbler, Arch. Protistk., vol. 3, 1903, p. 281, fig. 131 (in text).

*Description.*—Test of several coils, usually planospiral, each coil usually constricted to form several chambers, but the early coils sometimes unconstricted, wall composed of fine sand and a yellowish-brown or reddish-brown cement, fairly smooth, chambers variable in length, aperture large, with thickened lips.



Figs. 142–144.—Trochamminoides proteus. × 25 (after Brady).

Diameter 1–1.5 mm.

*Distribution.*—There are but two records for this species in the North Pacific, one *Challenger* station 224 in 1,850 fathoms, west of the Caroline Islands, and the other *Albatross* station H4566, at a depth of 572 fathoms, near the Hawaiian Islands, recorded by Bagg.

This species in its typical form is clearly divided into chambers of uniform size, especially in the last-formed coils, but the earlier coils may be undivided or irregularly constricted. Its development indicates the derivation of the many-chambered planospiral forms from a type like *Ammodiscus*.

The eight figures given by Karrer show various forms of tests, planospiral or involute, undivided tests belonging to *Ammodiscus* or *Gordiammina* and other trochoid divided tests like true *Trochammina* and in fig. 8 a test similar in form to the recent specimens placed under this specific name. Brady[a] has already noted the various forms grouped by Karrer under this species and has proposed the restriction of the name given by Karrer to the form represented by fig. 8 of Karrer. This seems reasonable, and I have adopted the same restriction.

Haeusler's figures also show various forms under this specific name. The specimen shown in fig. 24 may belong here, but the others are hardly this species as here restricted.

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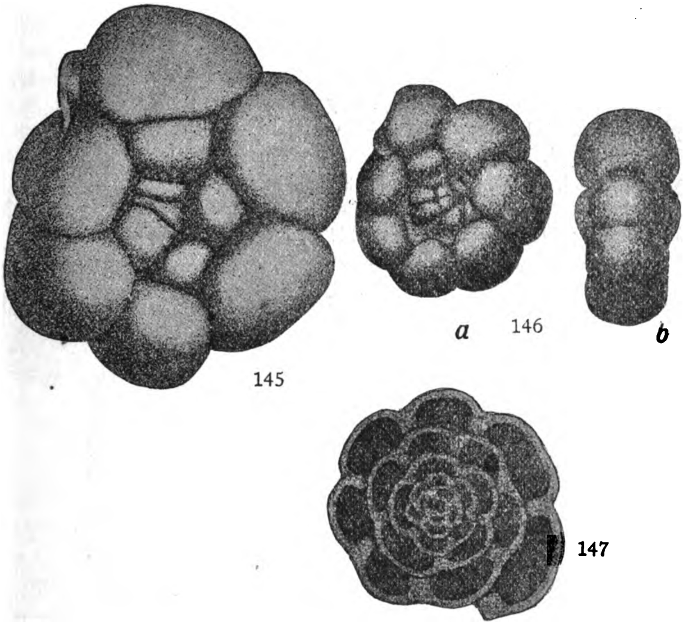
[a] Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 341.

### Genus HAPLOPHRAGMOIDES, new genus.

*Description.*—Test free, planospiral, composed of several coils, each composed of a number of chambers, wall arenaceous, varying much in texture and in the relative amount of cement in the different species, aperture at the ventral border or on the lower portion of the apertural face of the chamber.

*Type of the genus.*—*Haplophragmium canariense* d'Orbigny.

Included in this genus are the various completely coiled, planospiral, arenaceous species with simple apertures which have usually been assigned to *Haplophragmium* or *Trochammina*. The type-species of the former genus is an uncoiled form with multiple apertures, and the type-species of the latter genus has a trochoid spiral test. As here recognized, the species of this new genus have approximately an equal portion of the chambers of the test visible from the two sides. I have included here both the species with an excess of cement often assigned to *Trochammina* and those of coarser texture, which have been assigned to *Haplophragmium*.



Figs. 145–147.—Haplophragmoides coronata. × 20 (after Brady). 145, large specimen from side. 146 *a*, from side; *b*, apertural view. 147, section.

#### HAPLOPHRAGMOIDES CORONATA (H. B. Brady).

*Trochammina coronata* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58, pl. 5, fig. 15; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 340, pl. 40, figs. 10–12.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 26, fig. 3.

*Description.*—Test planospiral, fairly smooth, composed of three to six coils, the outer ones somewhat embracing, but all more or less visible from either side, chambers somewhat inflated, usually six to seven in the last-formed coil, distinct; aperture simple, at the ventral border of the apertural face, sometimes with traces of a lip present; wall composed of fine sand, usually with a reddish cement, but very variable in color, from white to brown.

Diameter 2–2.5 mm.

*Distribution.*—The only record for this species in the North Pacific is that of the *Challenger*, station 238, in 3,950 fathoms, east of Japan. This is the deepest sounding of the *Challenger* expedition from which material was examined.

### HAPLOPHRAGMOIDES TRULLISSATA (H. B. Brady).

*Trochammina trullissata* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56, pl. 5, figs. 10 *a*, *b*, 11; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342, pl. 40, figs. 14–16 (not fig. 13).—Haeusler, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 64, pl. 10, figs. 9, 11.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 265, pl. 5, figs. 25, 26 [?].—Chapman, Proc. Zool. Soc. London, 1895, p. 18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 33.—Millett, Journ. Roy. Micr. Soc., 1899, p. 364.

*Description.*—Test spirally coiled, made up of about three coils, not completely involute, somewhat umbilicate, so that the chambers of early coils are visible at the center, usually about nine chambers in the last-formed coil, chambers subglobular, aperture slightly above the base of the apertural face of the chamber, elongate, test smoothly finished exteriorly; color yellowish or reddish brown.

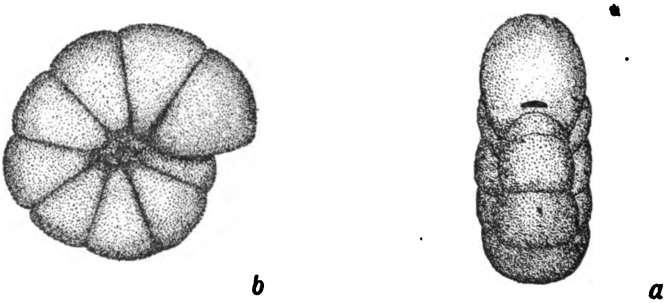


Fig. 148.—Haplophragmoides trullissata. × 75. Specimen from 2,875 fathoms, *Albatross* station H2916. *a*, side view; *b*, apertural view of same specimen.

Diameter, 1–1.25 mm.

*Distribution.*—This species is recorded from six widely distributed *Challenger* stations in the North Pacific, varying in depth from 1,850–3,950 fathoms. Goës records it from three *Albatross* stations in the eastern Pacific at the entrance to the Gulf of California and off Panama in 978–1,218 fathoms. In the material I have examined, it has occurred at *Albatross* station H2916 in 2,878 fathoms near the Hawaiian Islands; at two *Nero* stations, 1014 in 1,987 fathoms, and 1085 in 2,360 fathoms, both north of Guam. In this same general region at *Alert* station 1169 the species was found in 2,113 fathoms.

As a rule, this seems to be a decidedly deep-water species, as the additional records of this work confirm. Specimens never seem to be plentiful, occasional specimens occurring in the washed material from these stations.

### HAPLOPHRAGMOIDES CANARIENSIS (d'Orbigny).

*Nonionina canariensis* D'ORBIGNY in Barker-Webb and Berthelot, Hist. Nat. Îles Canaries, vol. 2, pt. 2, Foraminifères, 1839, p. 128, pl. 2, figs. 33, 34.

*Placopsilina canariensis* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 301, pl. 10, figs. 13, 14.

*Lituola canariensis* W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, pl. 6, figs. 39, 40, 41.—H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 472.—CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, pl. 13, figs. 26–29.

*Lituola nautiloidea*, var. *canariensis* PARKER and JONES (part), Trans., Roy. Soc. London, vol. 155, 1865, p. 406, pl. 15, figs. 45*a*, *b*; pl. 17, figs. 92–95.

*Haplophragmium canariensis* SIDDALL and H. B. BRADY, Cat. Brit. Rec. Foram., 1879, p. 4.—BÜTSCHLI, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 192, pl. 5, fig. 17.—H. B. BRADY, Denkschr. kais. Akad. Wiss. Wien, vol. 42, 1881, p. 99; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 310, pl. 35, figs. 1–5.—HAEUSLER, Neues Jahrb., vol. 4, 1885, p. 12, pl. 1, figs. 17–20.—H. B. BRADY, PARKER and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 218, pl. 41, fig. 9.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1888, p. 330.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 34, pl. 4, figs. 1–3.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 261, pl. 5, figs. 27–29.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 20, pl. 5, figs. 92–101.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—CHAPMAN, Ann. Mag. Nat. Hist., ser. 6, vol. 16, 1895, p. 314, pl. 11, fig. 5; Proc. Zool. Soc. London, 1895, p. 16.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 30.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 359.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 277, pl. 20, fig. 3.—CHAPMAN, Trans. New Zealand Inst., vol. 38, 1905 (1906), p. 84; Journ. Queckett Micr. Club, vol. 10, 1907, p. 126, pl. 9, fig. 3.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

*Nonionina jeffreysii* WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 34, pl. 3, figs. 72, 73.

*Haplophragmium jeffreysii* BERTHELIN, Foram. de Bourgneuf et Pornichet, 1878, p. 24, No. 20.

*Description.*—Test free, nautiloid, composed of several coils partially involute or almost completely so, umbilicated, chambers subglobular, somewhat compressed laterally, from six to nine in each coil, walls arenaceous, made up of sand in various degrees of coarseness, but even when coarse usually fairly smooth on the exterior, thin, aperture an elongated slit-like opening at the base of the apertural face of the chamber; color brown or gray, often when brown the last formed chamber may be gray.

Diameter, 0.75–2 mm.

*Distribution.*—There are a considerable number of records for this species in the North Pacific. The *Challenger* report gives seven stations ranging from 1,850–3,950 fathoms, with one station on the coral reefs of Honolulu at 40 fathoms. Goës records it at three *Albatross* stations off the coasts of Mexico and Central America in 660–1,879 fathoms. Flint records it from a single station, *Albatross* D3080, in 93 fathoms off the coast of Oregon. Bagg records it from two *Albatross* stations, H4566 in 572 fathoms and H4696 in 367 fathoms, both stations near the Hawaiian Islands. In the present work I have had specimens from *Albatross* station D3431 off California, D4965, D4993, D5068, 77–191 fathoms off the coast of Japan; *Nero* stations 1308, 1311, in 1,040 and 1,503 fathoms near the Bonin Islands. Specimens were also obtained from the stomachs of Holothurians taken at *Albatross* station D3608 in Bering Sea.

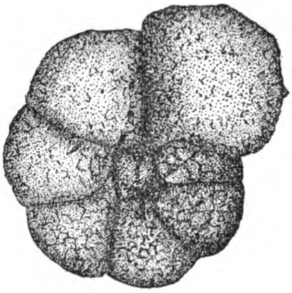


FIG. 149.—HAPLOPHRAGMOIDES CANARIENSIS. × 20.

There is a considerable variation in the texture of the wall, some specimens being smooth and of very fine material, resembling certain species of *Trochammina*, while others are of much coarser material. In general, however, the exterior of the test is smoothly finished. A considerable variety of forms have been assigned to this species by various authors, but I have placed here only those specimens which have the somewhat compressed form with the rounded chambers, which are characteristic of d'Orbigny's type figure.

### HAPLOPHRAGMOIDES EMACIATUM (H. B. Brady).

*Haplophragmium emaciatum* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 305, pl. 33, figs. 26–28.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 16.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 262, pl. 5, figs. 53, 54.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 276, pl. 19, fig. 5.
*Haplophragmium compressum* MILLETT [not *Haplophragmium compressum* Goës], Journ. Roy. Micr. Soc., 1899, p. 359, pl. 5, fig. 8.

*Description.*—Test nautiloid, planospiral, laterally compressed, consisting of two or more coils, chambers slightly involute, seven or eight in the last formed coil, usually rather indistinctly marked on the exterior; wall rather coarsely arenaceous, often with sponge spicules cemented into the test, aperture an elongated slit at the base of the apertural face; color usually brownish or gray.

Diameter 1–1.5 mm.

*Distribution.*—There are apparently no published records for this species in the North Pacific. In the *Albatross* and *Nero* collections the species occurs at several stations. Single specimens were obtained from three *Albatross* stations off Japan, D4970 in 500 fathoms, D4979 in 943 fathoms, and D5086 in 292 fathoms. Single specimens were obtained from two *Nero* stations, 12 off the Hawaiian Islands, 1,924 fathoms, and 172 in 2,086 fathoms near

FIGS. 150-152.—HAPLOPHRAGMOIDES EMACIATUM. × 20. FROM PHOTOGRAPH.

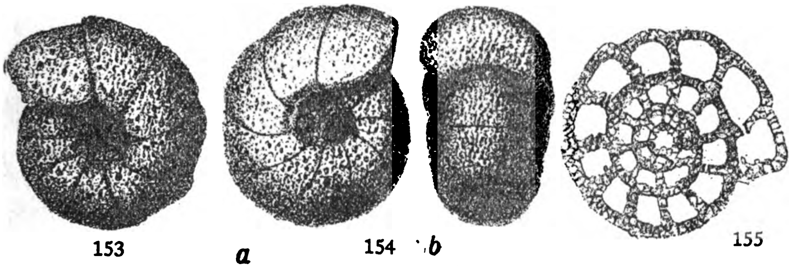
Midway Island. A single specimen from *Alert* station 1178 in 623 fathoms off San Augustino Island, belongs to this species.

From the series of specimens I have been able to obtain for study it seems a questionable point as to whether *H. compressum* of Goës is really the same as *H. emaciatum* H. B. Brady. As far as I have observed there is no tendency for any of the Pacific specimens to uncoil in later growth, and the aperture always remains a slit at the base of the apertural face. In the West Indian material which may be referred to *H. compressum* Goës there is a decided tendency to uncoil and a coincident change in the position of the aperture occurs. The specimen figured by Millet seems to be a close-coiled form and is included here.

### HAPLOPHRAGMOIDES SCITULUM (H. B. Brady).

*Haplophragmium scitulum* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 308, pl. 34, figs. 11–13.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 16.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 276, pl. 20, fig. 2.

*Description.*—Test nautiloid, planospiral, consisting of about three coils, not completely involute so that at the umbilical region the earlier coils are exposed; wall composed of firmly cemented sand grains; from seven to eleven chambers make up the last-formed coil, the chambers being wide and broadly rounded at their peripheral edge give the whole test a much broader form than seen in *H. canariense;* chambers nearly flush with one another, giving a fairly even periphery to the test, aperture a somewhat curved slit at the base of the apertural face; color of the test various shades of brown.



FIGS. 153–155.—HAPLOPHRAGMOIDES SCITULUM. × 40 (AFTER BRADY). 153, SIDE VIEW. 154*a*, SIDE VIEW; *b*, APERTURAL VIEW. 155. SECTION.

Diameter 0.75–1 mm.

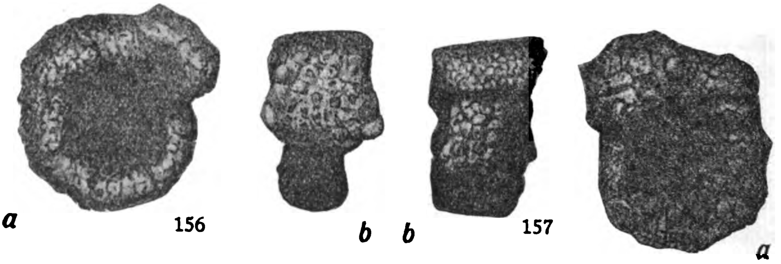
*Distribution.*—This species seems to be rare in the North Pacific. In the *Challenger* report it is recorded but once, from station 244 in 2,900 fathoms. Bagg records it from four *Albatross* stations in the vicinity of the Hawaiian Islands, 367–1,544 fathoms. I have seen material from but four other *Albatross* stations, D3431, at the entrance to the Gulf of California, 995 fathoms; H2774, off the California coast in 469 fathoms; D5018, in 100 fathoms in the Okhotsk Sea; and D4998 in 66 fathoms in the Gulf of Tartary off the southwestern coast of Sakalin Island, bottom temperature 35.9° F.

This species seems to be distinct from *H. canariense* and may be distinguished by its broader form, more deeply excavated umbilici, and the wider, flattened chambers.

### HAPLOPHRAGMOIDES ROTULATUM (H. B. Brady).

*Haplophragmium rotulatum* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 306, pl. 34, figs. 5, 6.—Chapman, Proc. Zool. Soc. London, 1895, p. 16.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 261, pl. 5, figs. 43, 44.

*Description.*—Test nautiloid, planospiral, composed of about three coils, wall fairly thick, of rather coarse sand particles, slightly rough on the exterior, chambers very broad and low, the peripheral margin much flattened, somewhat involute but the preceding coils exposed at the umbilical region, deeply concave on each side at the umbilici; chambers about nine in the last-formed coil, but rather indistinct when viewed from the exterior; aperture a narrow slit at the base of the apertural face; color brown.



Figs. 156–157.—Haplophragmoides rotulatum. × 50 (after Brady). *a, a*, front views; *b, b*, apertural views.

Diameter 0.56–0.75 mm.

*Distribution.*—Brady gives but a single North Pacific station, *Challenger* station 244 in 2,900 fathoms, but the volume on the "Summary of Results" adds two *Challenger* stations, 237 in 1,875 fathoms and 246 in 2,050 fathoms. The only specimen I have seen referable to this species is a single one from the coast of California, *Albatross* station H2681 in 486 fathoms, and this may perhaps be an extremely broad form of *H. scitulum*.

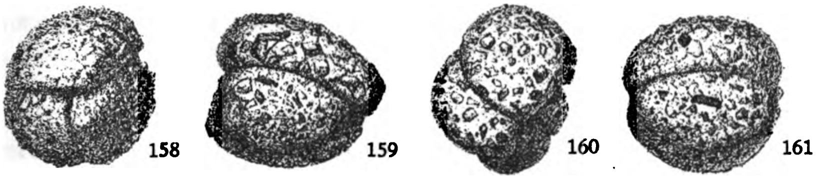
### HAPLOPHRAGMOIDES GLOMERATUM (H. B. Brady).

*Lituola glomerata* H. B. Brady, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 433, pl. 20, figs. 1*a–c*.

*Haplophragmium glomeratum* Wright, Proc. Belfast Field Club, 1880–81 (App.), p. 180, pl. 8, figs. 1, 1*a*.—H. B. Brady. Denkschr. kais. Akad. Wiss. Wien, vol. 43, 1881, p. 100; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 309, pl. 34, figs.

15–18.—Balkwill and Millett, Journ. Micr. and Nat. Sci., vol. 3, 1884, p. 25, pl. 1, fig. 6.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1885, p. 329.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 23, pl. 5, figs. 134–136 [not figs. 137–139].—Chapman, Proc. Zool. Soc. London, 1895, p. 15.

*Description.*—Test planospiral, composed of about two coils, chambers very low and broad making a subglobose test, usually three or four chambers making up the last-formed coil, slightly concave at the umbilici, wall coarsely arenaceous, rather rough, thin; aperture at the base of the apertural face consisting of a short slit which is often obscured by sand grains; color variable, depending largely upon the material composing the test.



Figs. 158–161.—Haplophragmoides glomeratum. × 100 (after Brady).

Diameter 0.25–0.75 mm.

*Distribution.*—Brady gives but one North Pacific *Challenger* station for this species, off the Philippines in 2,550 fathoms. The volume on the "Summary of Results" also gives a record off Japan, *Challenger* station 237 in 1,875 fathoms.

A number of specimens from *Nero* station 1295, in 1,415 fathoms between Yokohama and Guam, are possibly this species. Otherwise I have seen no North Pacific material referable to it.

### HAPLOPHRAGMOIDES SUBGLOBOSUM (G. O. Sars.)

*Lituola subglobosa* M. Sars, Forh. Vid. Selsk. Christiania, 1868 (1869), p. 250, (*nomen nudum*).—G. O. Sars, Forh. Vid. Selsk. Christiania, 1871 (1872), p. 253.

*Haplophragmium subglobosum* H. B. Brady, Denkschr. kais. Akad. Wiss. Wien, vol. 43, 1881, p. 100; Ann. Mag. Nat. Hist., ser. 5, vol. 8, 1881, p. 406.

*Haplophragmium latidorsatum* H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 307, pl. 34, figs. 7, 8, 10, 14 [?] (not fig. 9), and subsequent authors (not *Nonionina latidorsata* Bornemann, 1855).

*Description.*—Test usually planospiral consisting of two or more coils, involute, depressed at the umbilici, chambers very broad and low, wall arenaceous somewhat roughened but variable, chambers usually seven or eight in the last-formed coil, making the test as a whole subglobose, aperture a more or less elongated slit at the base of the apertural face, simple; color gray or brown.

Diameter 1–2.5 mm.

*Distribution.*—As *Haplophragmium latidorsatum* this species has been widely recorded. There are given eleven *Challenger* stations in the North Pacific for this species, ranging from 1,850–3,950 fathoms. Goës records it at several *Albatross* stations off the west coast of Mexico and Central America in 772–1,879 fathoms. Bagg gives four stations near the Hawaiian Islands, 367–1,342 fathoms. From the *Albatross* and *Nero* material I have examined this species is noted from many stations; *Albatross* D3603, from Holothurian stomachs, specimens taken in 1,771 fathoms in Bering Sea; from H3012 in 2,067 fathoms, between California and Hawaii; D4832, D4957, D4958 in 76, 437, and 405 fathoms, respectively. It occurred at a number of *Nero* stations in the dredgings from the Hawaiian Islands west across the Pacific, the depths varying from 1,040 to 2,226 fathoms.

The work of Brady in referring to *Nonionina latidorsata* Bornemann the recent species so common in the Arctic has been followed by most later writers. After a careful study of Bornemann's original figure and description I am unable to find clear enough reasons for giving Bornemann's name to our species. The figure and description call for a test which has high compressed chambers with the apertural face quadrangular, while in recent specimens the apertural face of the last chamber is typically very much wider than high. The form of the test is usually more globose than in Bornemann's figure and the test presents a very different appearance. As it is definitely known what the types of *subglobosum* are and as they are typical of the recent material it has seemed to me better to use Sars's name rather than to refer all our recent material to a rather indefinite fossil species.

162 163 164

FIGS. 162–164.—HAPLOPHRAGMOIDES SUBGLOBOSUM. × 16. FROM PHOTOGRAPH. 163. APERTURAL VIEW.

The form with its aperture consisting of a number of pores which is included by Brady under *Haplophragmium latidorsatum* seems to be very distinct, and as far as the North Pacific material is concerned has a definite distribution. It will be considered there as generically distinct from the planospiral forms with simple apertures.

I have not attempted to give the complete synonymy as many later authors have referred specimens to *Haplophragmium latidorsatum* without figures or description, and without seeing the original material a clearing up of the synonymy is impossible.

In the North Pacific this species seems to be common in cold or deep waters and is well distributed, being perhaps the most common of the chambered arenaceous forms.

### HAPLOPHRAGMOIDES SPHÆRILOCULUM, new species.

*Description.*—Test free, nautiloid, planospiral, consisting of five chambers in the last-formed coil, partially involute, chambers very globose, inflated, sutures depressed, peripheral margin of test deeply indented, aperture at the base of the apertural face; wall of fine arenaceous material smoothly cemented; color yellowish-brown.

Diameter about 1 mm.

*Type-specimen.*—Cat. No. 8218 U.S.N.M., from *Albatross* station D4970 in 500 fathoms off Japan. Another specimen was found in material from *Albatross* station D4957 in 437 fathoms, also off Japan.

This species differs from other planospiral arenaceous forms in the spherical character and position of the chambers, which are well separated so that their globose character is given its full value in shaping the test.

FIG. 165.—HAPLOPHRAGMOIDES SPHÆRILOCULUM. × 30. FROM PHOTOGRAPH.

### HAPLOPHRAGMOIDES RINGENS (H. B. Brady).

*Trochammina ringens* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 57, pl. 5, figs. 12*a*, *b*; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 343, pl. 40, figs. 17, 18.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 33.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 27, fig. 1.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 365, pl. 5, fig. 14 [?].—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 129.

*Ammochilostoma ringens* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 692.

*Description.*—Test spirally coiled, planospiral, of few coils, chambers usually completely involute covering the previously formed coils, chambers high, narrow, biconvex, usually with 3–5 in the lastformed coil; the last-formed chamber being much higher than preceding ones, peripheral edge somewhat sharp, surface smooth and polished, aperture slightly arcuate, somewhat above the base of the apertural face usually in a sort of depression of the wall; color various shades of brown.

Longer diameter 1.5 mm.

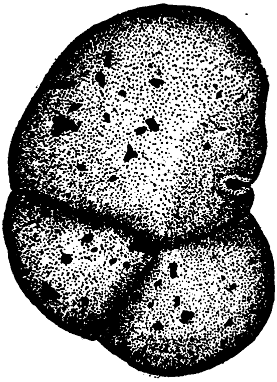


FIG. 166.—HAPLOPHRAGMOIDES RINGENS. × 45.

*Distribution.*—Although Brady states in his volume of the *Challenger* "Report" that the species seems to be limited to the Atlantic, in the volume on the "Summary of Results" this species is recorded from station 237, 1,875 fathoms, off Japan. Goës records this species as very scarce from a single *Albatross* station off Panama, D3375 in 1,201 fathoms. Flint records it from another *Albatross* station, D2923, in 822 fathoms off California.

Bagg records it from a single *Albatross* station near the Hawaiian Islands, H4590, in 978 fathoms, rare. I have found specimens from two North Pacific stations, *Albatross* D4979, off Japan, in 943 fathoms, and from *Alert* station 1156 in 2,046 fathoms south of Japan, near the Bonin Islands.

This seems to be a rare species and to occur in small numbers when found. In its earlier development the chambers are somewhat less flattened and of nearly equal height in the coil, but in the later development the chambers become high and the last-formed chamber in the adult is often much longer than any of the preceding ones.

The specimen figured by Millett is not typical, the last-formed chamber being of very different form from that usually seen in the specimens I have examined.

### CRIBROSTOMOIDES, new genus.

*Haplophragmium* H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 307.

*Description.*—Test free, planospiral, of several coils, chambered, the last-formed coil with several chambers progressively increasing in size, arenaceous wall, with much cement usually of a light-brown color, aperture in young specimens a simple elongate slit at the base of the apertural face, later subdivided by tooth-like processes, and in the adult represented by a linear series of distinct rounded openings.

*Type of genus.*—*Cribrostomoides bradyi*, new species.

This genus, while in general character is similar to *Haplophragmoides*, differs very distinctly in the apertural characters and in their development.

#### CRIBROSTOMOIDES BRADYI, new species.

*Haplophragmium latidorsatum* H. B. Brady (part), (not Bornemann), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 307, pl. 34, fig. 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 29 (part).

*Description.*—Test free, nautiloid, rotund, large, composed of seven to nine rotund chambers in the outer visible coil, umbilicate on both sides, wall composed of very fine arenaceous material with much cement, surface smooth, even; in front view broad, chambers rather low but broad, involute, aperture at first an elongate curved slit, later with the growth of tooth-like projections from the two sides it becomes subdivided so that in adult specimens the aperture is really multiple, consisting of a linear series of rounded openings instead of a single slit; color light grayish or yellowish brown.

Diameter up to 3 mm.

*Distribution.*—Specimens of this species were found in the Goës collection, his series of specimens from *Albatross* station D3419 in 772 fathoms being all of this species, but labeled "*Haplophragmium latidorsatum.*" In the same general region, the west coast of Mexico and the United States, the species has occurred in quantity at *Albatross* station D3346 off Washington, 786 fathoms, and at station D3431 in the Gulf of California, 995 fathoms. As is the case with many of our west coast species of foraminifera, this species is again seen in material from the coast of Japan. It occurred at *Albatross* station D4975 in 712 fathoms, and D5078, in 514 fathoms. Specimens, possibly the young of this species, were obtained at two *Nero* stations 1184 and 1287, in 1,542 and 1,606 fathoms.

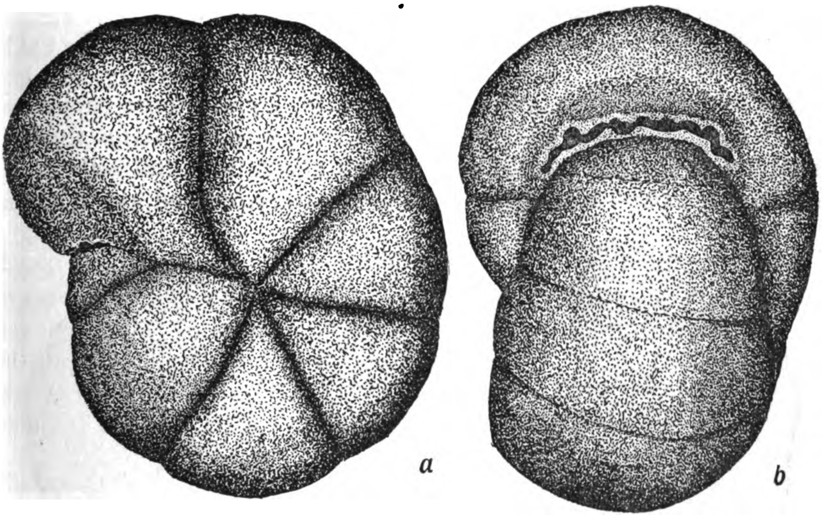


FIG. 167.—CRIBROSTOMOIDES BRADYI. × 20. *a*, SIDE VIEW; *b*, APERTURAL VIEW.

A large series of specimens like that from *Albatross* station D. 3346 shows that this is a very different species from any of the described forms to which it has usually been united. The characters in the material studied are little modified by variation.

### Genus CYCLAMMINA H. B. Brady, 1876.

*Lituola* W. B. CARPENTER (part), The Microscope, 5th ed., 1875, p. 536.—CARTER, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 203.

*Cyclammina* H. B. BRADY (MS.) in NORMAN, Proc. Roy. Soc. London, vol. 25, 1876, p. 214; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 350. Type, *Cyclammina cancellata* H. B. BRADY.

*Description.*—Test free, composed of numerous chambers in a close-coiled nautiloid series, final revolution usually completely embracing the preceding ones except at the umbilicus; walls thick, composed of fine arenaceous material with a reddish-brown cement, exterior smooth, chambers with secondary labyrinthic structures interiorly, especially on the peripheral portion of each chamber, early chambers often becoming completely filled by this secondary growth; aperture a curved fissure at the proximal portion of the apertural face, supplemented by numerous pores on the apertural wall itself.

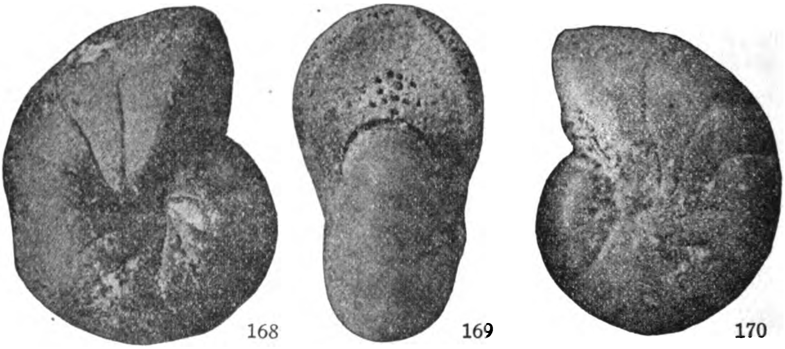
### CYCLAMMINA CANCELLATA H. B. Brady.

"Nautiloid *Lituola*" W. B. Carpenter, The Microscope, 5th ed., 1875, p. 536, figs. 274*a*, *b*, *c* (in text).

*Cyclammina cancellata* H. B. Brady (MS.) in Norman, Proc. Roy. Soc. London, vol. 25, 1876, p. 214; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 62; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 351, pl. 37, figs. 8–16.—Agassiz, Bull. Mus. Comp. Zoöl., vol. 29, 1888, p. 164, figs. 498, 499 (in text).—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 470.—Chapman, Proc. Zool. Soc. London, 1895, p. 18.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 32.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 282, pl. 27, fig. 3; pl. 28, fig. 1.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 129.

*Lituola canariensis* Carter, Ann. Mag. Nat. Hist., ser. 4, vol. 19, 1877, p. 203, pl. 13, figs. 26–29.

*Description.*—Test nautiloid, biconvex or slightly more convex at one side, umbilicated, chambers numerous, averaging about thirteen chambers in the last-formed coil, usually about three full coils in the adult test; sutures seen from the side somewhat curved anteriorly in the middle; exterior smooth and imperforate when perfect, interior of the chambers labyrinthic, the structure thus formed almost or quite filling the earlier developed chambers, peripheral edge of test rounded, with little trace of depressions at the sutures of the chambers; aperture an elongated slit near the base of the apertural face, supplemented by a series of pores occupying the central part of the apertural face, often becoming very numerous in very large specimens; color reddish-brown.



Figs. 168–170.—Cyclammina cancellata. × 16. From photograph. 169. Apertural view. The megalospheric form of the species with fewer chambers in each whorl, and attaining, when fully developed, a smaller size than that of the microspheric form.

Diameter up to 6.5 mm.

*Distribution.*—The *Challenger* obtained this species at stations 237 and 244 in the North Pacific east from Japan, in 1,875 and 2,900 fathoms. Goës records it from three *Albatross* stations off the coast of Mexico, 660–995 fathoms. Bagg records it from two stations in the vicinity of the Hawaiian Islands, 495 and 865 fathoms. Flint records it from *Albatross* station D2860 in 876 fathoms off the coast of British Columbia. I have found the species in material from *Albatross* station D3346 in 786 fathoms off Oregon, H1135 in 2, 848 fathoms just south of Unalaska, Aleutian Islands, and twice in the vicinity of Japan, D4900 and D4975, in 139 and 712 fathoms.

As a rule, this species seems to be found in cold and rather deep water, following rather well the faunal lines already spoken of in the introduction.

The microspheric form of the species grows to a large size with more complicated labyrinthic structures and apertures. The megalospheric form is smaller and less complicated in its structure. The two forms are shown in Flint's plates, plate 27, fig. 3, showing the microspheric form, plate 28, fig. 1, the megalospheric. The megalospheric proloculum is considerably larger than that of the microspheric form.

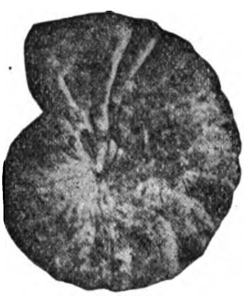


FIG. 171.—CYCLAMMINA CANCELLATA. × 8. FROM PHOTOGRAPH. THE MICROSPHERIC FORM OF THE SPECIES WITH A LARGER NUMBER OF CHAMBERS IN THE ADULT WHORLS AND ATTAINING A LARGER SIZE THAN THE MEGALOSPHERIC FORM.

### CYCLAMMINA PUSILLA H. B. Brady.

*Cyclammina pusilla* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 53.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 32, pl. 6, figs. 242–244.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 18.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 32.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 282, pl. 28, fig. 2.

*Description.*—Test nautiloid, small, compressed, umbilicate, peripheral edge rather thin, almost keeled in some specimens, often lobulated by successive chambers, composed of three coils, the last-formed one enveloping the others except at the umbilicus; wall finely arenaceous, inclined to be porous, especially within, but not building definite labyrinthic structures; aperture a curved slit at the base of the apertural face; color reddish-brown.

Diameter 0.5–1.5 mm.

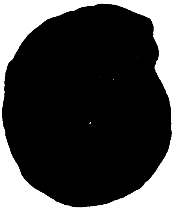


FIG. 172.—CYCLAMMINA PUSILLA. × 25. FROM PHOTOGRAPH.

*Distribution.*—There are two *Challenger* records for this species, stations 237 and 246, at 1,875 and 2,050 fathoms, one east of Japan, the other in the middle of the North Pacific. Goës found the species at two *Albatross* stations in the eastern tropical North Pacific in 772–1,201 fathoms. Flint records this species from *Albatross* station D3080, off the coast of Oregon, in 93 fathoms. I have found specimens at one station near the Hawaiian Islands, *Nero* station 2032 in 1,014 fathoms; also at three *Nero* stations 1134, 1305, 1308, near the Bonin Islands in the northwestern Pacific, 2,879, 1,289, and 1,040 fathoms; and at two *Albatross* stations of the 1902 cruise, D4957 D4958, at 405 and 437 fathoms, off the south coast of Japan.

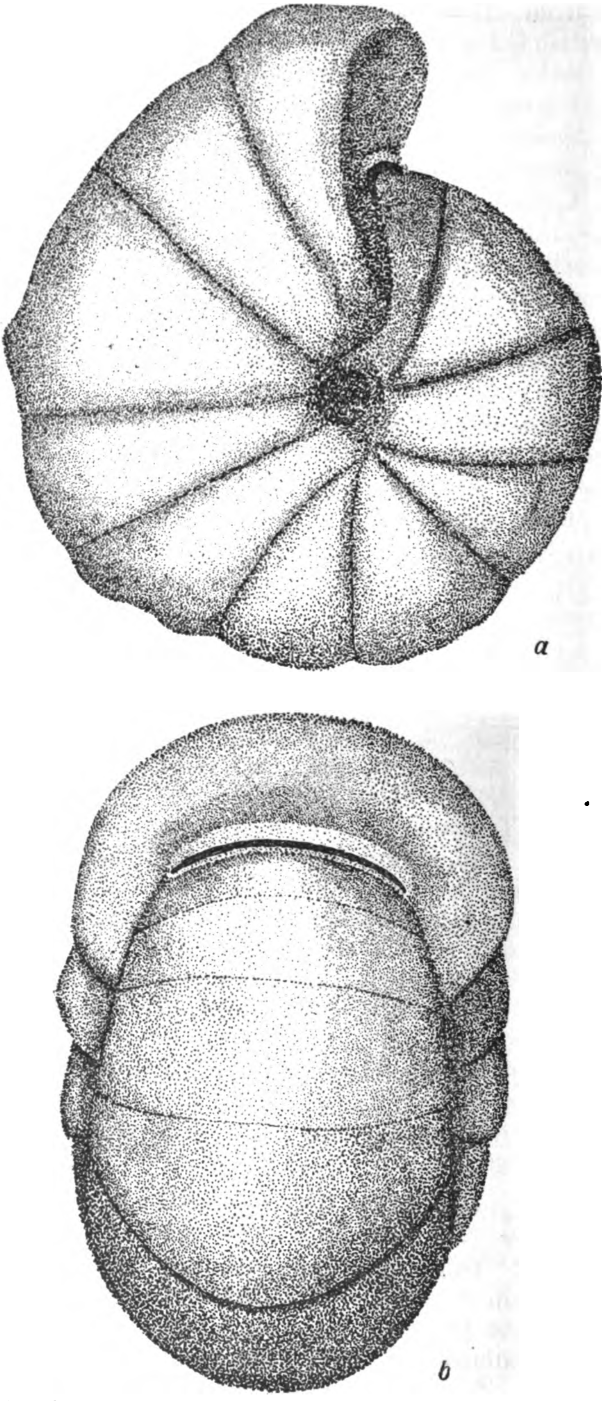


FIG. 173.—CYCLAMMINA ORBICULARIS. × 35. *a*. SIDE VIEW; *b*, APERTURAL VIEW.

As in the case of the preceding species this is limited to the deeper and colder waters, as far as the records show.

### CYCLAMMINA ORBICULARIS H. B. Brady.

*Cyclammina orbicularis* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 53; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 353, pl. 37, figs. 17–19.

*Description.*—Test nautiloid, subglobose, hardly umbilicate, peripheral edge rounded, composed usually of less than two complete coils, the outer one completely hiding those previously developed, wall finely arenaceous, somewhat labyrinthic within; aperture a curved slit at the base of the apertural face; color reddish-brown.

Diameter 1.5–2 mm.

*Distribution.*—There are four specimens in the Goës material from *Albatross* station D3419, 772 fathoms off the west coast of Mexico, that seem to belong to this species. A specimen from *Nero* station D1204, in 846 fathoms off Japan, may be the young of this species.

### CYCLAMMINA BRADYI, new species.

*Trochammina trullissata* H. B. Brady (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342, pl. 40, fig. 13 (not 14, 15).

*Description.*—Test free, spiral, nearly completely involute, compressed, slightly excavated at the umbilicus, last volution with six to nine chambers, smooth on the exterior, aperture crescentiform at the base of the apertural face, not included in the wall but between it and the preceding volution; apertural face occasionally with perforations in adult specimens; color yellowish or reddish brown.

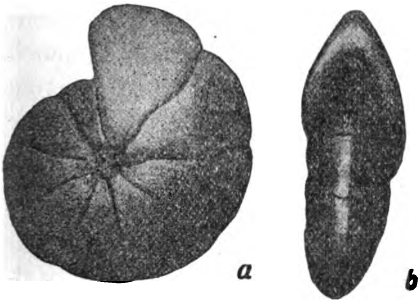


Fig. 174.—Cyclammina bradyi. × 30 (after Brady). *a*, side view; *b*, apertural view.

Diameter 1.2–1.5 mm.

*Distribution.*—Single specimens occurred at two *Nero* stations, 1134 in volcanic mud, 2,879 fathoms, and station 1305 in globigerina ooze, in 1,289 fathoms.

The specimen figured by Brady as *Trochammina trullissata*, referred to above, seems to belong here. It is evidently a *Cyclammina* in its characters and very different from the other specimens figured as *T. trullissata*. This species is at once distinguished from the young of *Cyclammina cancellata* and from *C. pusilla* by the smaller number of chambers in each volution.

*Type-specimen.*—Cat. No. 8212, U.S.N.M.

## Genus LITUOTUBA Rhumbler, 1895.

*Trochammina* (part) H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342.

*Lituotuba* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 83. Type, *L. lituiformis* (H. B. Brady) = *Trochammina lituiformis* H. B. Brady.

*Description.*—Test of two distinct parts, an early close-coiled portion and a long tubular uncoiled later portion; wall arenaceous, with an excess of cement, either indistinctly or irregularly divided.

This genus seems related, on the one hand, to *Ammodiscus* through such a form as *Trochamminoides proteus* (Karrer), but shows a definite senescent character in its uncoiled form. Besides certain fossil species this genus includes the following recent species:

### LITUOTUBA LITUIFORMIS (H. B. Brady).

*Trochammina lituiformis* H. B. Brady, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 59, pl. 5, fig. 16; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 342, pl. 40, figs. 4-7.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 281, pl. 26, fig. 1.—Bagg, Proc. U.S. Nat. Mus., vol. 34, 1908, p. 128.

*Lituotuba lituiformis* Rhumbler, Nachr. kön. Ges. Wiss. Göttingen, 1895, p. 84.

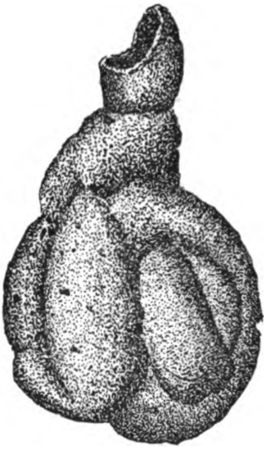


Fig. 175.—Lituotuba lituiformis. × 50.

*Description.*—Test composed of a close-coiled early portion and a later uncoiled portion, straight and tubular; irregularly or indistinctly divided into chambers; wall arenaceous with an excess of cement, aperture at the end of the tubular portion; color yellowish-brown.

Length up to 3.7 mm.

*Distribution.*—Bagg records a single specimen of this species from *Albatross* station D4000 in 104–213 fathoms near the Hawaiian Islands. Single specimens have occurred at two *Nero* stations, 1330 in 1,543 fathoms, and 1439 in 1,901 fathoms, in the western North Pacific, north of Guam.

This species appears to be rare in the North Pacific, but three specimens having been obtained from the dredgings.

## Genus AMMOBACULITES, new genus.

*Spirolina* (part) d'Orbigny, Foram. Foss. Vienne, 1846, p. 137.

*Haplophragmium* (part) H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 301.

*Description.*—Test free, chambered, early portion close coiled in one plane, later portion uncoiled and made up of a more or less linear series of chambers; wall coarsely arenaceous, fairly thick; aperture single at the center of the terminal face of the uncoiled portion, but in the coiled portion at the base of the apertural face.

This genus is more like the typical *Haplophragmium* described by Reuss, but although it is uncoiled in later growth it does not have the multiple apertures or the interior structure of that genus. It is evidently derived from the genus *Haplophragmoides* and its early development is similar to that genus. The true *Haplophragmium* is represented in the recent ocean by few species which have the multiple apertures and the other characters of the genus, but they are to be distinguished from the species included under this genus.

*Type.*—*Ammobaculites agglutinans* (d'Orbigny).

### AMMOBACULITES AGGLUTINANS (d'Orbigny).

*Spirolina agglutinans* D'ORBIGNY, Foram. Foss. Vienne, 1846, p. 137, pl. 7, figs. 10–12.

*Haplophragmium agglutinans* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 301, pl. 32, figs. 19–26.—HAEUSLER, Neues Jahrb., Beil., vol. 4, 1885, p. 13, pl. 1, figs. 22, 23; pl. 2, figs. 3, 4.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 330, pl. 13, figs. 18–20.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 484, pl. 11, fig. 8.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 32, pl. 3, figs. 32, 36; pl. 4, figs. 5, 6, 18.—FORNASINI, Foram. Plioc. Pont. Savena, pl. 2, fig. 5.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 324, pl. 5, fig. 14.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 260, pl. 4, figs. 16, 36.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 23, pl. 5, figs. 140, 141.—CHAPMAN, Ann. Mag. Nat. Hist., vol. 16, 1895, p. 313, pl. 11, fig. 2; Proc. Zool. Soc. London, 1895, p. 16.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 32.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 357, pl. 5, fig. 1.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

*Haplophragmium calcareum* FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 275, pl. 19, fig. 1 (not *H. calcareum* d'Orbigny).

*Description.*—Test free, elongate, early portion closely coiled, planospiral, of one or more volutions, each with five to seven chambers, later portion uncoiled, made up of a linear series of chambers, in adult specimens making up the larger portion of the test, wall rather coarsely arenaceous, variable in its surface, sometimes fairly smooth, sometimes rough; aperture in the early chambers at the base of the apertural face, but in the uncoiled portion in the middle of the terminal face, single, circular; color very variable from light to dark gray or brown.

Diameter of coiled portion about 1 mm., total length up to 3 mm.

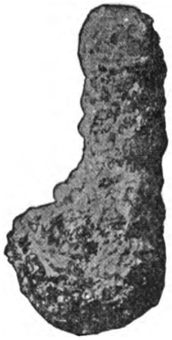


FIG. 176.—AMMOBACULITES AGGLUTINANS. × 25. FROM PHOTOGRAPH.

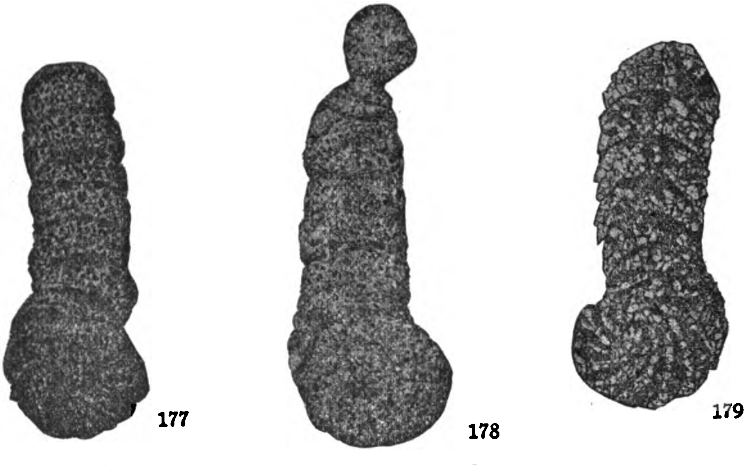
*Distribution.*—Brady records this species from five *Challenger* stations in the North Pacific, giving the depths as 7–3,125 fathoms. I am unable to find a record giving the shallowest station, but the other four range as follows: 2,050, 2,300, 2,900, and 3,125 fathoms, showing that it occurred as a rule in deep water. Bagg records the species from one station near the Hawaiian Islands, *Albatross* D4174, in 735–865 fathoms. I have found specimens of this species from six North Pacific stations. Single specimens were obtained from three *Albatross* stations near the Hawaiian Islands—H2764 in 122 fathoms, H2999 in 549 fathoms, and H3009 in 603 fathoms. It was obtained in material taken from the stomachs of Holothurians dredged at *Albatross* station D3603, 1,771 fathoms in Bering Sea, and at two *Nero* stations—1308 in 1,040 fathoms and 1410 in 1,144 fathoms—between Yokohama and Guam.

The early chambers of this species are not compressed as in the following species, but are of nearly equal diameter to those of the uncoiled portion. The species is represented by few specimens, but seems to be well distributed. There is some considerable variation in the color and texture of the material forming the wall. There is usually a rather small amount of cement visible, so that the finish of the surface of the wall depends upon the character of the material. Where the wall is smooth the chambers may easily be made out, but in the rougher specimens it is hard to distinguish their limits.

### AMMOBACULITES FOLIACEUS (H. B. Brady).

*Haplophragmium foliaceum* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 304, pl. 33, figs. 20–25.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 276, pl. 19, fig. 6.

*Description.*—"Test crosier-shaped, complanate, very thin, flat on both sides; consisting of numerous segments, the earlier ones forming two or three convolutions of a flat spire, the later ones arranged in a broad, straight, linear series. Segmentation distinct; peripheral edge slightly constricted at the sutures; septal lines arched. Aperture simple, terminal."



Figs. 177–179.—Ammobaculites foliaceus. × 40 (after Brady). 177 and 178, side views; 179, specimen mounted in Canada balsam and viewed by transmitted light.

Length $\frac{1}{20}$ inch (1.25 mm.).

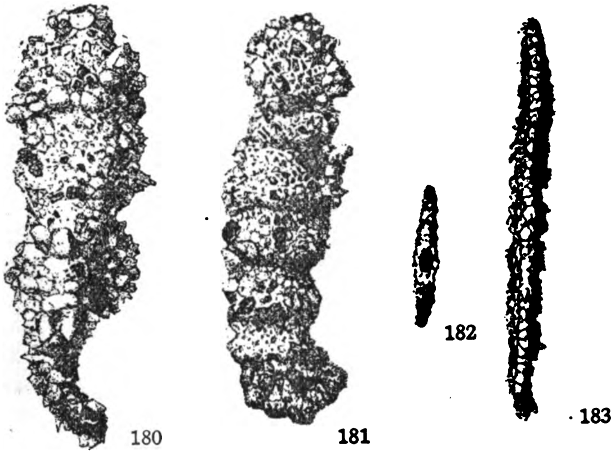
*Distribution.*—Brady records this species from a single *Challenger* station, No. 232, in 345 fathoms, on the *Hyalonema* ground, south of Japan. The specimens are recorded as "of poor dimensions and few in number."

### AMMOBACULITES TENUIMARGO (H. B. Brady).

*Haplophragmium tenuimargo* H. B. Brady, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 303, pl. 33, figs. 13–16.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 275, pl. 19, fig. 3.

*Description.*—"Test elongate, crosier-shaped, much compressed; lateral edges thin and jagged. Spiral segments few and small; those of the linear series about six in number, broad and slightly convex; septation obscure. Aperture simple, irregular in form; terminal. Texture coarse, surface extremely rough."

Length $\frac{1}{10}$ inch (2.5 mm.) or somewhat less.



FIGS. 180–183.—AMMOBACULITES TENUIMARGO. × 25 (AFTER BRADY). 180, 181, FROM SIDE. 182, APERTURAL VIEW. 183, FROM EDGE, SHOWING THICKNESS OF TEST.

*Distribution.*—Brady records this species from a single *Challenger* station, No. 238, in 3,950 fathoms, east of Japan. I have seen no specimens referable to this species in the material I have examined from the North Pacific.

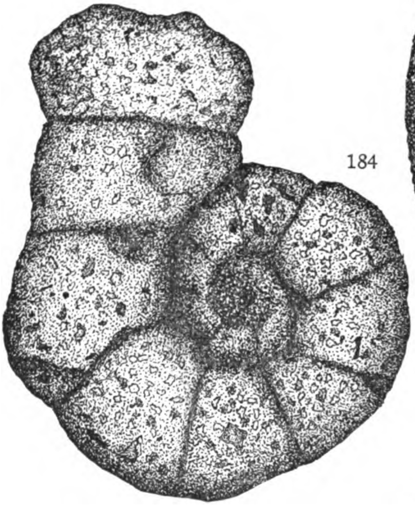
### AMMOBACULITES AMERICANUS, new species.

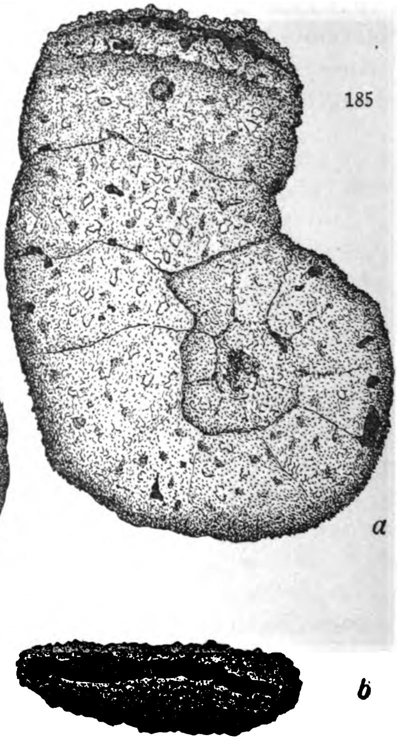
*Haplophragmium fontinense* H. B. Brady (not *H. fontinense* Terquem), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 305, pl. 34, figs. 1–4.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 31.

*Description.*—Test planospiral, compressed, slightly or not at all involute, the two sides alike, composed of three or four volutions with about nine chambers in the outer volution, the last formed chambers in fully grown specimens tending to form an uncoiled straight growth, wall made up of sand grains firmly cemented; aperture elongate, oval, or forming a long slit across the apertural face of the chamber; color, gray.

*Distribution.*—Specimens were found by Goës in material from *Albatross* station D3419 in 772 fathoms, off the west coast of Mexico.

This is a very different species from that described by Terquem from the Oolite of France. The original description of that species refers to a test convex on one side and concave on the other. The recent species is the same on each side and truly planospiral. The aperture varies in the recent specimens, but is usually rather elongate, and the test six times as large as the fossil species described by Terquem.





FIGS. 184–185.—AMMOBACULITES AMERICANUS. 184. × 20. 185 *a*, BROADER, MORE FLATTENED FORM; *b*, APERTURAL VIEW, × 15.

## Genus PLACOPSILINA d'Orbigny, 1850.

*Placopsilina* D'ORBIGNY, Prodr. Pal., vol. 2, 1850, p. 96.—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 315.

*Description.*—Test attached, chambered, the early portion close-coiled, later portions uncoiling and spreading out in an irregular but in general a linear series of chambers, building no floor; last portion of the test may be entirely free, made up of an irregular series of chambers; wall arenaceous, aperture rounded, at the end of the last formed chamber.

### PLACOPSILINA CENOMANA d'Orbigny.

*Placopsilina cenomana* d'Orbigny, Prodr. Pal., vol. 2, 1850, p. 185, no. 758.—Reuss, Denkschr. kais. Akad. Wiss. Wien, vol. 7, 1854, p. 71, pl. 28, figs. 4, 5.—Bütschli, in Bronns Klassen und Ordnungen des Thierreichs, vol. 1, 1880, p. 191, pl. 5, fig. 19.—Haeusler, Quart. Journ. Geol. Soc., vol. 39, 1883, p. 27, pl. 3, fig. 1; Neues Jahrb., vol. 1, 1883, p. 59, pl. 3, figs. 12–14.—H. B. Brady, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 315, pl. 36, figs. 1–3.—Wright, Proc. Belfast Nat. Field Club., 1884–85, App. 9, 1886, p. 320, pl. 26, figs. 3*a*, *b*.—Haeusler, Neues Jahrb., Beil., vol. 4, 1885, p. 8, pl. 1, figs. 24, 25.—Howchin, Journ. Roy. Micr. Soc., 1888, p. 536, pl. 8, fig. 4.—H. B. Brady, Parker, and Jones, Trans. Zool. Soc., vol. 12, 1888, p. 218, pl. 42, fig. 13.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Chapman, Proc. Zool. Soc. London, 1895, p. 17.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 4, pl. 1, fig. 7.

*Lituola cenomana* Jones and Parker, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 302.—H. B. Brady, Proc. Somerset Arch. and Nat. Hist. Soc., vol. 13, 1867, p. 105, pl. 1, fig. 1.

*Lituola* (*Placopsilina*) *cenomana* W. B. Carpenter, Parker, and Jones, Intr. Study Foram., 1862, p. 143, pl. 11, figs. 11–14.

*Description.*—Test attached, many chambered, the earlier portion close coiled, more or less completely involute, of one or more volutions, later portion uncoiled, forming a linear or irregular series of chambers but building no floor, the body to which it is attached serving as the lower wall, last formed portion in adult specimens or those which are attached to small objects rising free from the attachment and making an irregular cylindrical growth and building a wall on all sides except where it is in contact with the previously formed chamber; wall arenaceous, variable in the finish of its surface, usually rough; aperture fairly large, rounded; color variable, usually gray but occasionally brownish.

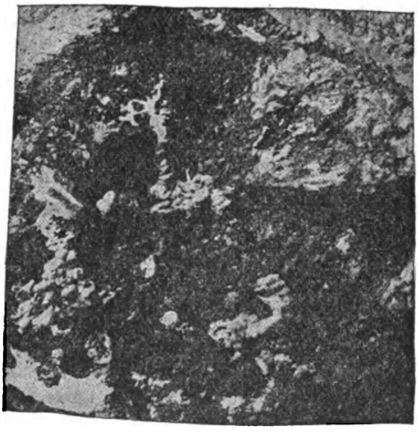


Fig. 186.—Placopsilina cenomana. × 10. From photograph. Specimen attached to stone.

Length in adults up to 5 mm., diameter 0.5–1 mm.

*Distribution.*—A single specimen was found at *Albatross* station D4900 in 139 fathoms, off Japan.

If one looks up the various figures assigned to this species, a very variable lot of things will be met with. I am not at all certain that the recent material should be assigned to the cretaceous species which d'Orbigny had, for even in recent material many specimens which at a glance would be placed with this species are seen by close study to be rugose species with smooth calcareous tests in the young and belong with the Rotalidæ. If fossilized it would be difficult to distinguish such tests from truly arenaceous ones by superficial examination.

### Genus TROCHAMMINA Parker and Jones, 1860.

*Nautilus* (part) MONTAGU, Test. Brit., Suppl., 1808, p. 81.

*Rotalina* (part) WILLIAMSON, Recent Foram. infera of Great Britain, 1858, p. 50.

*Globigerina* (part) WILLIAMSON, Recent Foram. infera of Great Britain, 1858, p. 56.

*Trochammina* (part) PARKER and JONES, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 337.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 695. Type, *T. inflata* (MONTAGU) = *Nautilus inflatus* MONTAGU.

*Lituola* (part) PARKER and JONES, Trans. Roy. Soc. London, vol. 155, 1865, p. 407.

*Haplophragmium* (part) SIDDALL and H. B. BRADY, Cat. Brit. Rec. Foram., 1879, p. 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312.

*Ammoglobigerina* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 704.

*Description.*—Test free or sometimes adherent, spiral, trochoid, chambered; all chambers visible when viewed from above, only the chambers of the last formed volution visible from below; wall arenaceous usually with considerable cement; aperture an arched slit on the ventral side of the chamber at its contact with the preceding volution.

As here considered, *Trochammina* is restricted to those species like *T. inflata* or *T. squamata*, which have a true spiral, trochoid test with all the chambers visible only from above.

#### TROCHAMMINA SQUAMATA Jones and Parker.

*Trochammina squamata* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 304.—W. B. CARPENTER, PARKER, and JONES, Intr. Study Foram., 1862, p. 141, pl. 11, fig. 1.—PARKER and JONES, Trans. Roy. Soc. London, 1865, p. 407, pl. 15, figs. 30, 31 *a–c*.—H. B. BRADY, Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 288, pl. 11, fig. 4; Quart. Journ. Micr. Sci., vol. 19, 1879, p. 56.—HAEUSLER, Neues Jahrb., 1883, pt. 1, p. 60, pl. 4, fig. 8.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 337, pl. 41, figs. 3 *a–c*.—HAEUSLER, Neues Jahrb., Beil., vol. 4, 1885, p. 29, pl. 3, fig. 30.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 331.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 65, pl. 10, figs. 27–29, 40.—J. WRIGHT, Proc. Roy. Irish Acad., vol. 1, 1891, p. 469.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 264, pl. 5, figs. 4–6.—EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 695, fig. 43 (in text).—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 362.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 5.

*Trochammina proteus* KARRER (part), Sitzb. kais. Akad. Wiss. Wien, vol. 52, 1865, p. 494, pl. 1, fig. 6 (not 1–5, 7, 8).

*Description.*—Test free or sometimes adherent, trochoid spiral, flattened, consisting of three to four volutions with four or five chambers in each, convex above, flattened or somewhat concave below, all chambers visible on the dorsal surface, only those of the last formed volution visible from below; wall composed of sand grains of varying size and a considerable amount of cement, surface fairly smooth; aperture a somewhat arched slit between the wall of the chamber and the adjacent chamber of the previous volution on the lower side of the test; color reddish-brown.

Diameter 0.75–1.25 mm.

*Distribution.*—There are no previous published records for this species in the North Pacific. It has occurred at three *Albatross* stations, D5095 in 58 fathoms in the Gulf of Tokyo and H4881 in 316 fathoms near Blake Reef, Vincennes Strait, southern Japan. A single large specimen was obtained.

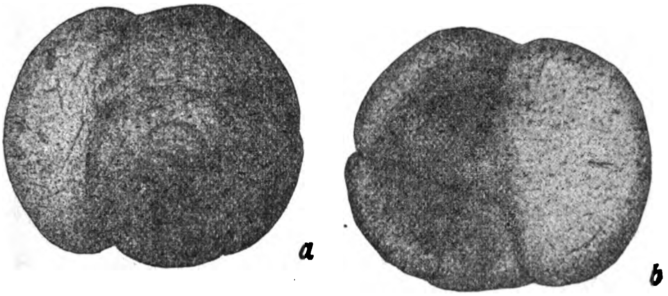


FIG. 187.—TROCHAMMINA SQUAMATA. × 50 (AFTER BRADY). *a*, FROM ABOVE; *b*, FROM BELOW.

This species is much flatter than the preceding and has fewer chambers in each volution.

### TROCHAMMINA INFLATA (Montagu).

*Nautilus inflatus* MONTAGU, Test. Brit., Suppl., 1808, p. 81, pl. 18, fig. 3.

*Rotalina inflata* WILLIAMSON, Recent Foraminifera of Great Britain, 1858, p. 50, pl. 4, figs. 93, 94.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 3, vol. 4, 1859, p. 347, fig. F.—WILLIAMSON, Pop. Sci. Rev., vol. 4, 1865, p. 174, pl. 8, fig. 8.

*Trochammina inflata* W. B. CARPENTER, PARKER, and JONES, Intr. Foram., 1862, p. 141, pl. 11, fig. 5.—H. B. BRADY, Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865, p. 95.—HAEUSLER, Ann. Mag. Nat. Hist., ser. 5, vol. 10, 1882, p. 351, pl. 15, figs. 5–7; Neues Jahrb., 1883, pl. 1, fig. 60; pl. 4, figs. 6, 7.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 338, pl. 41, figs. 4*a–c*.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 331, pl. 13, figs. 11, 12.—HAEUSLER, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 65, pl. 10, figs. 25, 26.—WOODWARD and THOMAS, Geol. and Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 28, pl. D, fig. 31.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, pl. 5, figs. 10–12, 16–18.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, no. 9, 1894, p. 29, pl. 6, figs. 222–224.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 364.—FORNASINI, Mem. Real. Accad. Sci. Ist. Bologna, vol. 8, 1900, p. 367, fig. 15.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 6, pl. 1, fig. 9.

*Description.*—Test trochoid, spiral, composed of about three volutions, the last-formed one consisting of five or six inflated chambers, those of the inner volutions somewhat less inflated, all chambers visible from above, only those of the last-formed volution visible from below, spire low; test umbilicate below; wall composed of fine sand with an excess of cement, smooth, aperture small, a short arched slit where the chamber meets the previous volution on the ventral side and just in from the periphery; color yellowish-brown, the early chambers of the spire often darker than the rest.

Diameter 0.7–1 mm.

*Distribution.*—There seem to be no published records for the occurrence of this species in the North Pacific. In the material that I have examined it has been seen but once, from *Nero* station 1213, in 808 fathoms, off the coast of Japan.

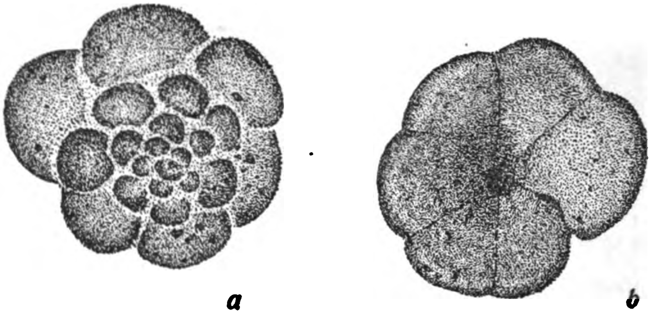


FIG. 188.—TROCHAMMINA INFLATA. × 50. *a*, FROM ABOVE; *b*, FROM BELOW.

### TROCHAMMINA TURBINATA (H. B. Brady).

*Haplophragmium turbinatum* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312, pl. 35. figs. 9, *a–c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 262, pl. 5, figs. 57–59.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 16.

*Trochammina turbinatum* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 695.

*Description.*—Test spiral, early volutions regular, low spired, last-formed volution in the adult somewhat irregular leaving the regular method of coiling and becoming oblique; five to eight chambers in the last-formed volution, umbilicate below, in adults with a depression above due to the obliquity of the last-formed volution; wall arenaceous, variable in coarseness and amount of cement, aperture a slit at the base of the ventral side of the chamber; color yellowish or reddish brown or grayish.

Diameter 0.75–1.25 mm.

*Distribution.*—Brady records this species from a single *Challenger* station, 246, in 2,050 fathoms. In the material that I have examined it has occurred at several stations: *Albatross* station D2806, in 1,379 fathoms near the Galapagos Islands; H1521, in 462 fathoms, off the west coast of the United States; D4998, in 66 fathoms, in the Gulf of Tartary off Sakalin Island; and D4979, in 943 fathoms, off Japan. Specimens were found from four *Nero* stations, 1139, 1147, 1184, and 1306, in 1,208–2,101 fathoms, between Yokohama and Guam.

There is a considerable variation in the texture of the specimens included here, but all have the same general characters.

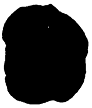


FIG. 189.—TROCHAMMINA TURBINATA. × 35. FROM PHOTOGRAPH.

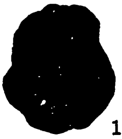
Goës figured and described a variety which he named *Haplophragmium turbinatum*, var. *helicoideum* Goës. Upon looking up the original series labeled by Goës with this name I find among the Pacific material a very much mixed series of tests. In all, there are ten Pacific specimens, none of which at all resembles the figures given by Goës.

### TROCHAMMINA NANA (H. B. Brady).

*Haplophragmium nanum* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Denkschr. kais. Akad. Wiss. Wien, vol. 43, 1881, p. 99, pl. 2, figs. 1, *a–e;* Ann. Mag. Nat. Hist., ser. 5, vol. 8, 1881, p. 406, pl. 21, fig. 1; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 311, pl. 35, figs. 6–8.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 14, 1888, p. 218, pl. 41. fig. 20.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 324, pl. 5, fig. 15.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 262, pl. 5, figs. 13–15.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 22, pl. 5, figs. 124–127.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 360, pl. 5, fig. 9.—RHUMBLER, Zool. Jahrb., vol. 24, 1906, p. 65, pl. 5, fig. 56.—BAGG, Proc. U. S. Nat. Mus., vol. 34, p. 127.

*Description.*—Test trochoid-spiral, spire very low, consisting of two or more volutions, the last-formed one with six to eight chambers, somewhat flattened above but usually rotund below, very slightly or not at all umbilicate, chambers all visible from the dorsal side, only those of the last-formed volution visible from the ventral side; walls composed of sand grains and a large amount of cement, surface fairly smooth; aperture an arched slit at the periphery and ventral edge of the chamber where it is in contact with the adjacent chamber of the preceding volution; color yellowish brown, the last-formed chamber often gray.

Diameter 0.21–0.75 mm.



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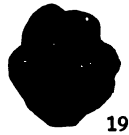

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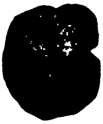

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FIGS. 190–192.—TROCHAMMINA NANA. × 35. FROM PHOTOGRAPH.

*Distribution.*—Brady mentions but one *Challenger* station for this species, 253, in 3,125 fathoms, but in the volume on the "Summary of Results" two other stations are added, 246, in 2,050 fathoms, and 237, in 1,875 fathoms, the last with a question mark. Rhumbler records a single young specimen from Laysan Island. Bagg records it from a single *Albatross* station, H4694, in 865 fathoms, off the Hawaiian Islands. I found several specimens in material from *Nero* station 992, in 1,013 fathoms, off Guam.

### TROCHAMMINA GLOBIGERINIFORMIS (Parker and Jones).

*Globigerina bulloides* Williamson, Recent Foraminifera of Great Britain, 1858, p. 56, pl. 5, figs. 116–118 (not *G. bulloides* d'Orbigny 1828).

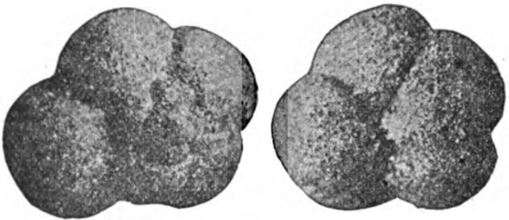
*Lituola nautiloidea*, var. *globigeriniformis* Parker and Jones, Trans. Roy. Soc. London, vol. 155, 1865, p. 407, pl. 15, figs. 46, 47.

*Lituola* (*Haplophragmium*) *globigeriniformis* Terrigi, Nuovi Lincei Atti, 1880, p. 175, pl. 1, fig. 3.

*Haplophragmium globigeriniforme* Siddall, Cat. Brit. Rec. Foram., 1879, p. 4.—W. B. Carpenter, The Microscope, 6th ed., 1881, p. 561, fig. 320 *a*, *b*.—H. B. Brady, Denkschr. kais. Akad. Wiss. Wien., vol. 43, 1881, p. 100; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312, pl. 35, figs. 10, 11.—Balkwill and Wright, Trans. Roy. Irish Acad., vol. 28, 1885, p. 329.—Haeusler, Abh. schweiz. pal. Ges., vol. 17, 1890, p. 36, pl. 4, figs. 13, 16, 17.—J. Wright, Proc. Roy. Irish Acad., vol. 1, 1891, p. 468.—Terrigi, Mem. Roy. Com. Geol. Italia, vol. 4, 1891, p. 68, pl. 1, fig. 7.—Chapman, Journ. Roy. Micr. Soc., 1892, p. 324, pl. 5, fig. 16.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 260, pl. 5, figs. 30, 31.—Goës. Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 22, pl. 5, figs. 128–133.—Chapman, Proc. Zool. Soc. London, 1895, p. 16.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 30.—Flint, Rep. U. S. Nat. Mus., 1897 (1899), p. 277, pl. 21, fig. 1.—Sidebottom, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, no. 5, 1905, p. 4, pl. 1, fig. 6.—Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 126.

*Ammoglobigerina bulloides* Eimer and Fickert, Zeitschr. wiss. Zool., vol. 65, 1899, p. 704.

*Description.*—Test free or adherent, spiral, trochoid, spire varying in its elevation, usually wider than high, chambers globose, all visible from above, only those of the last-formed coil visible from below; test composed of from two to four volutions, the last formed one usually of four, occasionally three, chambers, rapidly increasing in size progressively as added, wall of sand grains and a variable amount of cement, outer surface fairly even; aperture an arched slit on the ventral side of the chamber at its contact with the adjacent chamber of the preceding volution; color of the test reddish-brown.


193 194

Figs. 193–194.—Trochammina globigeriniformis. × 20. From photograph. 193, from above; 194, from below.

Diameter 0.5–1.5 mm.

*Distribution.*—This species is one of the most common of the arenaceous species in deep water. The *Challenger* obtained it at seven stations in the North Pacific in 15–3,950 fathoms, all but one in more than 1,800 fathoms. Goës records it at two *Albatross* stations in the eastern Pacific in 772–1,218 fathoms. Bagg records a few doubtful specimens from the vicinity of the Hawaiian Islands, *Albatross* station H4585 in 689 fathoms. In the present work I have found the species at numerous stations from 392–2,113 fathoms in depth in the *Albatross*, *Nero*, and *Alert* material. At *Albatross* station D3603 it was obtained from Holothurian stomachs at a depth of 1,771 fathoms. It has occurred in largest numbers about Japan.

This species belongs in the genus *Trochammina* as here recognized. It has a regular spirally-formed trochoid test like the other species of *Trochammina* included here and differs only in the very inflated, globular character of the chambers. The elevation of the spire varies somewhat, but as a rule the test is fully as broad as high. In the texture of the wall there is some variation, the amount of cement usually being considerable.

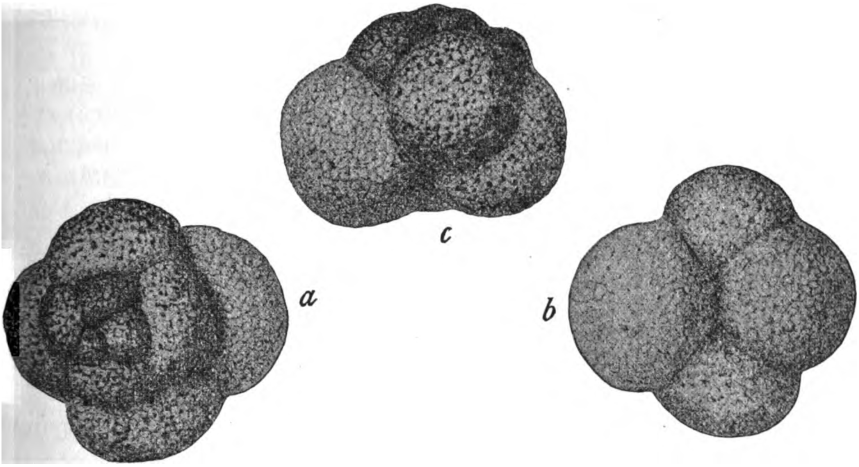


FIG. 195.—TROCHAMMINA GLOBIGERINIFORMIS. × 25 (AFTER BRADY). *a*, FROM ABOVE; *b*, FROM BELOW; *c*, FROM SIDE.

## Genus GLOBOTEXTULARIA Eimer and Fickert, 1899.

*Haplophragmium* (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313.

*Globotextularia* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 679.

*Description.*—Test arenaceous, the early chambers in a spire, the later ones irregular, globular, Globigerina like, containing only the following species:

### GLOBOTEXTULARIA ANCEPS H. B. Brady.

*Haplophragmium anceps* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313, pl. 35, figs. 12–15.—CHASTER, First Rep. Southport Soc. Nat. Sci., 1890–91 (1892), p. 57, pl. 1, fig. 2.—MILLETT, Proc. Roy. Micr. Soc., 1899, p. 361, pl. 5, fig. 10.

*Globotextularia anceps* EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 679, fig. 25 (in text).

*Description.*—Test irregular, early portion spiral with a high spire, compact, later portion with much larger globular chambers, irregular in position, usually four in regular specimens in the outer volution, wall arenaceous, surface fairly smooth; aperture near the inner end of the chamber; color brown.

Diameter 1.5 mm.

*Distribution.*—Although not recorded by Brady this species is given in the volume on the "Summary of Results" from *Challenger* station 237, 1,875 fathoms off Japan. There is a single specimen from *Albatross* station H2766 in 196 fathoms off California, which I have referred to this species.

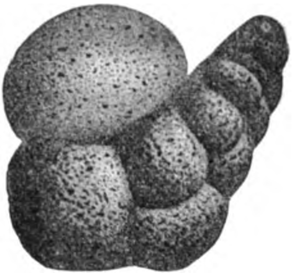


FIG. 196.—GLOBOTEXTULARIA ANCEPS. × 20 (AFTER BRADY).

### Genus AMMOCHILOSTOMA Eimer and Fickert, 1899.

*Trochammina* (part) H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58; vol. 21, 1881, p. 52; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 344.

*Haplophragmium* (part) H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 50; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 312.

*Ammochilostoma* (part) EIMER and FICKERT, Zeitschr. wiss. Zool., vol. 65, 1899, p. 692. Type, *A. pauciloculata* (H. B. BRADY)=*Trochammina pauciloculata* H. B. BRADY.

*Description.*—Test free, early chambers spiral, later ones very involute and the last-formed volution often entirely covering the previously formed chambers and usually at an oblique angle to the earlier growth; wall arenaceous with a variable amount of cement; aperture at or near the base of the apertural face of the chamber, elongate, narrow.

This name was proposed by Eimer and Fickert for three species of *Trochammina, T. ringens, T. galeata,* and *T. pauciloculata.* As the first of these species has already been included under *Haplophragmoides,* this name, *Ammochilostoma,* will stand for the other two species with others which in their last-formed volution become involute or irregularly winding about the test in a changing plane.

#### AMMOCHILOSTOMA PAUCILOCULATA (H. B. Brady).

*Trochammina pauciloculata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 58, pl. 5, figs. 13–14; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 344, pl. 41, figs. 1, 2.—EGGER, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 265. pl. 5, figs. 37, 38.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 33.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 282, pl. 27, fig. 2.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1907, p. 128.

*Ammochilostoma pauciloculata* EIMER and FICKERT, Zeitschr. wiss. Zoöl., vol. 65, 1899, p. 692.

*Description.*—Test ovoid, early chambers spiral, hidden by the later chambers which are in a plane oblique to the early ones and very involute, inflated, three or four chambers visible in an adult specimen; wall arenaceous with an excess of cement, smooth and polished, aperture an elongate slit at the base of the chamber; color yellowish or reddish brown with some of the chambers gray in some specimens.

Diameter 0.14–0.75 mm.

*Distribution.*—From the *Challenger* work there are four recorded stations in 1,850 to 3,950 fathoms. Goës records the species from a single *Albatross* station, 3375 in 1,201 fathoms, rare. I have examined the material selected by Goës and also that recorded by Bagg from the vicinity of Hawaii in 689–1,398 fathoms, and in both cases the material seems to be typical. The species has occurred at three *Nero* stations, 170 in 1,990 fathoms near Midway Island and at two stations 1155 and 1389 in 1,632 and 1,653 fathoms, between Yokohama and Guam. It has also occurred at three *Albatross* stations, H2898 and H2999, in 1,265 and 549 fathoms near the Hawaiian Islands, and D4979 in 943, fathoms off Japan.

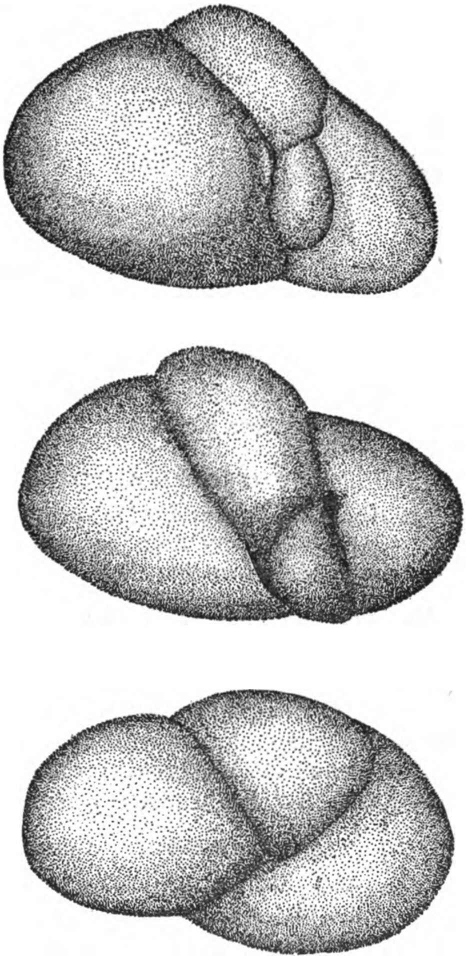


FIG. 197.—AMMOCHILOSTOMA PAUCILOCULATA. THREE VIEWS OF SAME SPECIMEN. × 100.

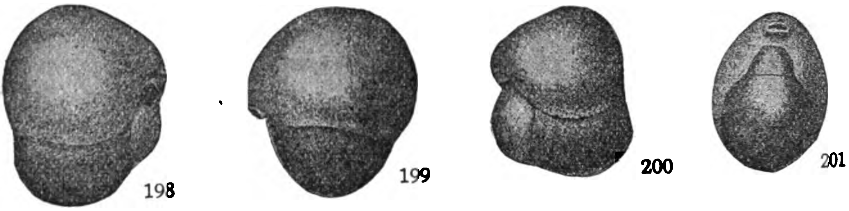
This is a very characteristic species of small size, and with little variation. It usually occurs in but few numbers and most of the stations for the species are in deep water.

### AMMOCHILOSTOMA GALEATA (H. B. Brady).

*Trochammina galeata* H. B. Brady, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 52 Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 344, pl. 40, figs. 19–23.—Egger, Abh. kön. bay. Akad. Wiss. München, vol. 18, 1893, p. 265, pl. 5, figs. 32–43.

*Ammochilostoma galeata* Eimer and Fickert, Zeitschr. wiss. Zoöl., vol. 65, 1899, p. 692, fig. 39 (in text).

*Description.*—Test nearly symmetrical, subglobular, early chambers spiral, the later ones enveloping the earlier ones, the last-formed chamber in the adult forming half the area of the test, wall arenaceous with much cement, smooth; aperture a narrow slit near the base of the apertural face; color yellowish-brown.



FIGS. 198–201.—AMMOCHILOSTOMA GALEATA. × 50 (AFTER BRADY). 201, APERTURAL VIEW.

Diameter 0.5 mm.

*Distribution.*—There are two *Challenger* records for this species in the North Pacific, 224 in 1,850 fathoms and 237 in 1,875 fathoms, both in the western Pacific.

## AMMOSPHÆROIDINA, new genus.

*Haplophragmium* (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313.—HOWCHIN, Trans. Roy. Soc. South Australia, vol. 12, 1889, p. 6.—CHAPMAN, Journ. Linn. Soc., Zoöl., vol. 30, 1907, p. 24.

*Description.*—Test globose, arenaceous, early portion spiral, later chambers like *Sphæroidina* in form, embracing; aperture rounded, at one side of the chamber in the adult.

*Type of the genus.*—*Haplophragmium sphæroidiniformis* H. B. Brady.

This genus in its general external characters much resembles *Spæroidina,* but has a rather coarse arenaceous test.

### AMMOSPHÆROIDINA SPHÆROIDINIFORMIS (H. B. Brady).

*Haplophragmium sphæroidiniformis* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 313.—HOWCHIN, Trans. Roy. Soc. South Australia, vol. 12, 1889, p. 6.—CHAPMAN, Journ. Linn. Soc., Zoöl., vol. 30, 1907, p. 24, pl. 3, figs. 50, 51.

*Description.*—Test free, composed of a spiral earlier portion, the later portion in the adult made up of usually three large globose chambers similar in form and arrangement to *Sphæroidina bulloides*, one large one at one side and two smaller ones at the other, the aperture at the inner side of the last-formed chamber semicircular or rounded; wall rather coarsely arenaceous; color brownish or gray.

Diameter 0.75–1.75 mm.

*Distribution.*—Specimens referred to this species have been obtained at seven stations in the North Pacific; *Albatross* stations H2986 in 271 fathoms and H3012 in 2,067 fathoms, both near the Hawaiian Islands; and at several *Nero* stations near Midway Island, near Luzon and between Yokohama and Guam in 1,406–2,135 fathoms.

The structural characters of this species will not allow of its being placed in any of the genera used here in a restricted sense and it has seemed best to make a new genus for it.

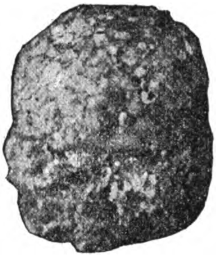


FIG. 202.—AMMOSPHÆROIDINA SPHÆROIDINIFORMIS. × 25. FROM PHOTOGRAPH.

### Subfamily 4. NEUSININÆ.

Test arenaceous with some chitin, flattened and broad, composed of many chambers, early portion coiled with the later chambers broad and spreading, sides with elongate chitinous filaments.

This subfamily containing the single species, *Neusina agassizii*, is different from the other arenaceous Foraminifera but in its general plan of structure is not unlike certain other genera.

### Genus NEUSINA Goës, 1892.

*Neusina* Goës (type, *Neusina agassizii* Goës), Bull. Mus. Comp. Zoöl., vol. 23, 1892, p. 195.

*Description.*—Test expanded, flat, made up of a series of very broad, low, flattened chambers, early ones in complete specimens apparently coiled, later ones in a broad, flat expanse of varying shape; wall arenaceous or of fine mud and sand with a chitinous network, flexible with a thread-like border of chitin; apertures numerous, along the edge of the chamber; color in fresh specimens brown.

#### NEUSINA AGASSIZII Goës.

*Neusina agassizii* Goës, Bull. Mus. Comp. Zoöl., vol. 23, 1892, p. 195, pl., figs. 1–9.

*Description.*—Similar to that of the genus, simply the one species being known.

Diameter in largest specimen, 190 mm.

*Distribution.*—Specimens of this species were found in material from a single *Albatross* station, D3399, off the northwest coast of South America in 1,740 fathoms in olive green ooze.

There has been much discussion as to whether this is really a foraminifer or not. It has many of the characters of the group and the main objection to placing it here is on account of its size. A single small specimen in the National Museum figured here shows something

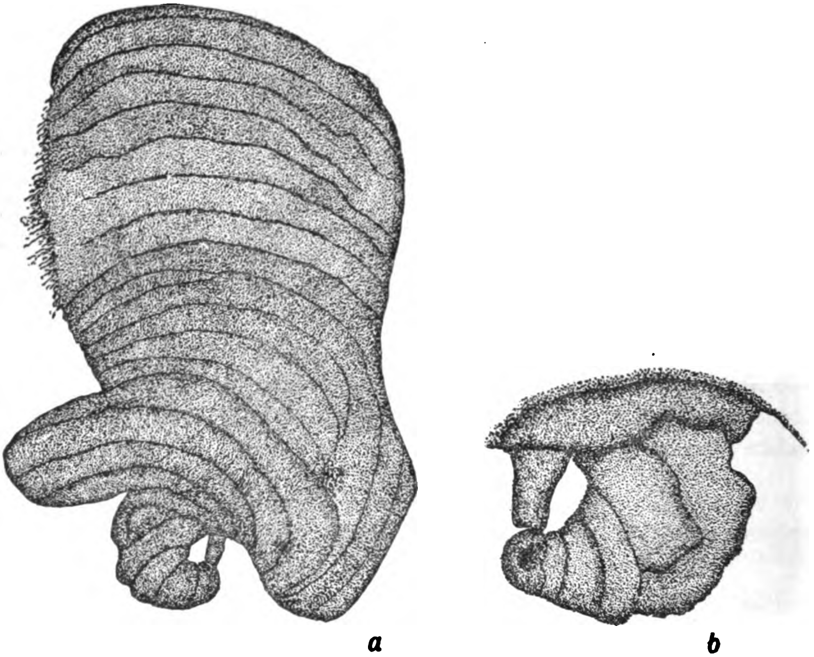


FIG. 203.—NEUSINA AGASSIZII. *a*, COMPLETE SPECIMEN, × 1⅓. *b*, EARLY PORTION OF SAME SPECIMEN FROM OPPOSITE SIDE, × 5.

of the early development. Evidently from this specimen there is a close coiled young, then an arcuate uncoiled growth, and finally the broad, flaring growth characteristic of the adult is taken on. The specimen was associated with *Rhizammina algæformis* H. B. Brady.

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